

The use of Haddon matrix of risk factors in prevention of burns in children: Review of the literature

Zastosowanie matrycy czynników ryzyka wg Haddona w profilaktyce oparzeń u dzieci – przegląd piśmiennictwa

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Abstract

Burns are a very common trauma in children under 5 years of age. Prevention of burns is crucial due to unsatisfactory results of the treatment. The aim of the study was to propose possible preventive measures to stave off burns in children using the Haddon matrix. We analyzed the risk factors of burns in children in 4 groups of factors according to the Haddon matrix: factors related to the person, burning factor, the physical environment, and socioeconomic environment. Then the above factors were divided depending on the time into having an effect before, during and after the event. Most of burned patients under 18 years of age at the time of injury were under parents' supervision. That is why preventive "pre-event" measures should be focused on educating caregivers of young children as well as on changes in the physical and socio-economic environment in order to minimize the risk of burns. At the time "after the incident", proper first aid is crucial – in most cases, it was administered incorrectly (no cooling of the wound, applying various substances on the wound, no analgesics). Medical personnel should be trained to provide specialized care for burned patients and their families. Haddon matrix can be used for more effective planning of preventive actions aimed at reducing the number of burns in children. It is essential to educate children's caregivers and medical staff.

Key words: children, prevention, burns, Haddon matrix

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Streszczenie

Oparzenia są urazem, na który narażone są szczególnie dzieci <5. r.ż. Z uwagi na wciąż niezadowalające wyniki leczenia kluczowe znaczenie ma profilaktyka. Celem pracy było zaproponowanie możliwych działań profilaktycznych zapobiegających oparzeniom u dzieci z użyciem matrycy Haddona. Poddano analizie czynniki ryzyka oparzeń u dzieci, wyodrębniając zgodnie z matrycą Haddona 4 ich grupy: związane z osobą, czynnikiem oparzającym, środowiskiem fizycznym oraz środowiskiem socjoekonomicznym. Następnie podzielono je w zależności od przedziału czasowego na mające znaczenie przed, w trakcie oraz po zdarzeniu. Z uwagi na to, że większość oparzonych <18. r.ż. w chwili urazu znajduje się pod opieką rodziców, działania profilaktyczne w fazie „przed zdarzeniem” powinny być ukierunkowane na edukację opiekunów małych dzieci i zmiany w środowisku fizycznym oraz socjoekonomicznym, które zminimalizują ryzyko oparzenia. W fazie „po zdarzeniu” ważne jest poprawne udzielenie pierwszej pomocy, która w większości przypadków przeprowadzana jest nieprawidłowo (brak schładzania rany, nakładanie różnych substancji na ranę, niestosowanie leków przeciwbólowych). Personel medyczny powinien być przeszkolony w zakresie specjalistycznej opieki zarówno nad oparzoną małą pacjentką, jak i jego rodziną. Matryca Haddona może być zastosowana w celu skuteczniejszego planowania działań profilaktycznych, aby zmniejszyć liczbę oparzeń u dzieci. Podstawowe znaczenie ma edukacja opiekunów dzieci oraz personelu medycznego.

Słowa kluczowe: dzieci, profilaktyka, oparzenia, matryca Haddona

Background

Burns are injuries that occur as a result of action of different types of energy exceeding protection capacity of the body.¹

According to academic division, depending on the cause, and thus the damaging energy, we can distinguish thermal burns, i.e., burns resulting from thermal energy, electrical – resulting from electricity, chemical – caused by chemical substances, and radiation burns – being a consequence of α or β particle radiation, γ radiation or X-ray radiation. Additionally, some authors also include mixed type of burns.¹

The observation shows that the thermal injuries are dominating and the majority of them are caused by fire. The second most frequently occurring burn wounds are scalds, resulting from contact with hot fluids.² Electrical and chemical burns are occasional.

Regional differences can be observed in terms of epidemiology. Worldwide, most burns (95%) occur in low-income countries.³

It is estimated that about 20% of burn cases are children under the age of 4, about 10% – children aged 5–14, 60% – adults in working age, and 10% – persons above the age of 65.²

Among minors, the highest risk group are boys under the age of 5. In Lower Silesia, approx. 1,000 children are hospitalized due to burns each year and above 1,000 of minors report to primary care physician.^{4,5} Similarly to worldwide statistics, thermal burns are dominating. They are usually located on the upper limb.

Burn risk is determined by various factors, including geographic, climatic (most burns occur in winter months) and socioeconomic ones. Children from large families are considered a higher-risk group. In literature, the importance of gross income per a household member is also highlighted, because it usually translates into housing conditions.⁶

Due to the fact that burns can lead to numerous complications, including life-threatening ones, and the fact

that the disfiguring scars resulting from them accompany patients all their lives, it is extremely important to prevent such injuries in children.

It should be emphasized that though the direct injury concerns the little patient, its indirect consequences are also experienced by close relatives, who often struggle with enormous feeling of guilt.

The consequences also have an economic dimension – medical treatment is very expensive. Some patients need hospitalization, intravenous fluid therapy, clinical nutrition, wide range of medications used in treatment, and sometimes also surgical procedures and rehabilitation.

According to World Health Organization (WHO), it is possible to decrease the mortality and morbidity rate through actions directed at minimizing not only the probability of injury, but also its severity and influence on the lives of patients suffering from burns.⁷

World Health Organization underlined the issue of burn prevention by publishing numerous studies on the subject.^{3,7}

The aim of this paper was to present the capacities of Haddon matrix tool in relation to preventing burns in children.

Theoretical framework

Haddon matrix is the framework constructed by William Haddon in the 2nd half of 20th century, originally in the context of the traffic safety.⁸ Then, it was also used in epidemiological issues. In later years, that tool was utilized for developing prevention of various injuries, including burns. Injuries are defined as unintentional or intentional bodily harms caused by exposure to energy (thermal, mechanical, electrical, or chemical), lack of oxygen or exposure to low temperatures.³

The matrix is made of 4 columns and 3 rows. The framework treats injuries as a results of interaction of a host – human, agent – energy and environment – both physical and social one.³ Thus, the framework presents

the “host – agent – environment” public health conception as an objective of changes in terms of primary, secondary and tertiary prevention.⁸

Matrix rows set in time the sequence of the events that can potentially lead to injury.³

The 1st row refers to primordial and primary prevention, that is the “pre-event” period, the 2nd to the event itself and the 3rd to the “post-event” stage, i.e., the broadly understood tertiary prevention.

There are 4 phases of prevention distinguished in literature that correspond with 4 different stages of disease: primordial prevention, primary prevention, secondary prevention, and tertiary prevention.⁹

Although all stages are important and complimentary to each other, the primordial and primary prevention seem to be of highest importance in the context of burns in children.

The objective of primordial prevention is to eliminate the social, economic and cultural patterns which contribute to increasing burn risk. Primary prevention shall be understood as prevention of diseases by developing control over their causes and risk factors. Preventive measures are targeted at the entire population or selected population groups. In the context of burns in children, preventative measures would be aimed at minimizing the risk of burn and preventing the injury by creating environment which is safe for a child (e.g., cool-touch exterior ovens).

Secondary prevention aims to detect and treat the disease early.⁹ In case of burns, the example can be correct provision of first aid, especially appropriate cooling of thermal injury which prevents the burn from getting worse. It is related to the fact that after the contact with burning factor (e.g., hot water) ceased, the burn gets worse if it is not cooled.

The objective of the tertiary prevention is to stop development of the disease, prevent complications and improve the quality of life. An example can be rehabilitation of children suffering from burns.

In 1st column in Haddon matrix, the factors related to a host are included, 2nd column shows the agent, 3rd column presents physical environment, and 4th column identifies social environment.⁸

Methodological assumptions

In the context of burns, the “pre-event” stage considerations (1st row) focus on the events that can cause injury, e.g., whether the pot of boiling water will topple over. In the “event stage” (2nd row), the center of attention is whether the injury will occur – whether the aforementioned toppling over of the pot will cause injury in a child. The “post-event” stage (3rd row) refers to the severity of the injury and its consequences – how severely the child is burned and whether he or she will receive an adequate aid and treatment.³

According to Runyan, correct application of Haddon matrix requires 12 steps to be taken^{8–11}:

1. Determine the problem that requires intervention. For this purpose, it is necessary to refer the needs of a certain community.
2. Define the matrix columns which will indicate the objective/area of changes (host, agent, physical environment, social environment).
3. Define matrix rows basing on the pre-event, event and post-event timeframes.
4. Set clearly defined value criteria.
5. Determine the weight of each value.
6. “Brainstorm” potential preventive measures (interventions) and fill in the cells made by columns and rows.
7. Organize and/or collect data in order to evaluate the proposed preventive measures (interventions) with regard to each of the earlier adopted criteria.
8. Evaluate each intervention according to its attributes in relation to the adopted criteria.
9. Carry out the overall assessment.
10. Choose the best way to solve the problem.
11. Explain decisions based on the adopted criteria and assess the possibilities for intervention according to the adopted guidelines.
12. Document the whole process so that to enable future reanalysis.

Risk factors of burns in children were analyzed by dividing them into 4 groups in accordance with Haddon matrix: those related to a human host, burning agent, physical environment, and socioeconomic environment. The factors were then divided further, depending on the time of occurrence, into: pre-event, event and post-event stages.

Tables 1–3 present the burn risk factors which are substantial in planning primary, secondary and tertiary prevention.

Before the event, educational measures are of key importance, especially education of guardians and children on burn prevention, e.g., not to leave little children without care or with inadequate care (e.g., older siblings, elderly grandparents). For this purpose, the burn prevention and first aid trainings may be organized for those who look after children and thus are the first ones to have contact with a child suffering from burns – namely, first of all, parents and teachers. It is important to pass the knowledge about burn prevention and first aid to children as well. The scope of information and teaching methods should be adequate to particular age group. For example: in the group of teenagers, a special attention should be paid to electrical burns which are more frequent at this age.

The proposed preventive measures related to burning agent include, for example, lowering the temperature of water in electric kettles and other water-heating devices.

The environment of a child should be safe – a minor should not have an access to vessels filled with boiling water, hot drinks and hot items. A proper storage of cor-

rosive chemicals is very important in the prevention of chemical burns.

Socioeconomic aspects of burn prevention include improving the quality of heating systems in flats and access to hot water, as well as prohibiting the sale of fireworks and other potentially dangerous materials to minors.

Preventive measures during the event aim to interrupt the activity of burning agent as quickly as possible. For example: in the context of flame burns, this function is fulfilled by fire alarms.

The most important in the "post-event" stage is providing first aid to the burned person. Preventive measures in the tertiary stage shall be thus directed at educating both the guardians of children – about first aid provided to people with burns, and medical personnel – about treating patients with burns. It should be noted that the knowledge about treating patients with burns should not be limited to burn treatment itself. Providing training to medical personnel on how to communicate with parents who are in a stressful situation is also necessary. Parents of young patients often feel guilty and experience difficult emotions, which affects the relation between a doctor and a patient's family, and the cooperation with guardians is of key importance in the process of treat-

ment. Thus, it is so important to provide a holistic care to the patient and the patient's family (in some cases, it also includes psychological support). The attention of the medical personnel should be also drawn to the specific features of intentional burns which may indicate the battered child syndrome; it is crucial that the medical personnel is taught how to act in such cases.

It is not uncommon for burns in children to occur in families where such incidents had taken place before, so even after the injury, the education of children and their families about burn prevention is important. If first aid was provided incorrectly, first aid training shall be provided. In addition, parents and guardians shall be advised on the necessary changes in their child's environment to minimize the risk of recurrent burn-related injuries, e.g., setting up a barrier preventing access to the kitchen. It is also fundamental to raise awareness of household members and persons who have a contact with the child of behaviors that increase the risk of burns in children, e.g., leaving cups with hot drink within the sight or reach of children.

Changes in socioeconomic environment should include better access to rehabilitation centers and specialized centers treating burns, and organizing support groups for children with burns and their parents.

Table 1. Risk factors of burns and primary prevention aspects (own translation)³

Tabela 1. Czynniki ryzyka oparzeń w aspekcie profilaktyki pierwszorzędowej (tłumaczenie własne)³

Stage	Human host	Burning agent	Physical environment	Social environment
Pre-event	– using fireworks; – smoking cigarettes at home, especially in bed; – lack of knowledge about risk factors of fire in a house	– storing inflammable substances at home; – storing inflammable materials, matches or lighters in places accessible to children; – dangerous furnaces and lamps which do not meet safety requirements	– poverty areas; – crowded flats/rooms; – kitchen space not separated from the rest of the house; – dangerous electrical wiring; – high temperature of water in heating devices	– poverty, unemployment, illiteracy; – no fire-related building codes; – social habits; – in Third World countries: the tacit acceptance of acid throwing

Table 2. Risk factors of burns and secondary prevention aspects (own translation)³

Tabela 2. Czynniki ryzyka oparzeń w aspekcie profilaktyki drugorzędowej (tłumaczenie własne)³

Stage	Human host	Burning agent	Physical environment	Social environment
Event	– poor equipment with smoke detectors and sprinklers; – dressing the child in clothes made of inflammable materials; – insufficient knowledge about evacuation mode and escape routes	– no fire sprinkler system; – no hydrants, difficult access to water	– no working fire alarms/smoke detectors; – no simple and accessible escape routes; – no access to phones to call help	– no legal regulations about installing smoke detectors and fire alarms in a house; – poor infrastructure in terms of emergency services communication

Table 3. Risk factors of burns and tertiary prevention aspects (own translation)³

Tabela 3. Czynniki ryzyka oparzeń w aspekcie profilaktyki trzeciorzędowej (tłumaczenie własne)³

Stage	Human host	Burning agent	Physical environment	Social environment
Post-event	– lack of knowledge about first aid	– inflammability of building materials, children clothing; – smoke and burning building materials toxicity	– providing first aid incorrectly; – insufficient equipment of emergency units; – unsatisfactory level of hospital care	– no access to burn centers and rehabilitation centers; – insufficient support of society

Conclusion

To conclude, in the context of burns, the measures related to primary, secondary and tertiary prevention are essential. Particular emphasis shall be put on the “pre-event” and “post-event” stages. Priorities include: preventing burns in children, and if they occur – providing correct first aid and adequate treatment. Thus, the primary and tertiary prevention seems to be of utmost importance.

Due to the fact that the majority of cases of burn in children under the age of 18 occur at the time when children are under parent supervision, the preventive measures in the “pre-event” stage shall be directed towards educating guardians of little children and towards changes in physical and socioeconomic environment, in order to minimize the risk of burn.

The most important preventive measures include: leaflets for guardians of the youngest children and drawing the attention of social service workers and community nurses to the home environment of the child in the context of burns (especially the methods of heating water and providing heat to the dwelling).

After the event, it is important to ensure provision of first aid, which in most cases is provided incorrectly (no cooling the burn wound, applying different substances in the wound, failure to apply analgesics). Medical personnel should be trained in specialist care for the young patient with burns and for the patient’s family.

Tertiary prevention needs to be based on specialist training of the medical personnel (doctors, nurses, paramedics, physiotherapists) in first aid and treating burns in patients. It should be also noted that in some cases, a psychologist should be involved in the therapeutic process. It is important to highlight the significance of advice provided to children’s guardians, which should not only refer to treatment but also to aftercare and prevention of similar injuries in the future.

The role of education in burn prevention is underlined in numerous publications of WHO, which proposes the “3E” approach. The 1st E means education, the 2nd – engineering and the 3rd – enforcement.³

The aim of education is to raise awareness and decrease the frequency of risk behaviors. In injury prevention, the areas of focus may be the population or risk groups. Education is considered necessary and yet insufficient to change people’s behavior. For example: gaining knowledge about the necessity of using fire alarms should correspond with the increased access to such devices.

The 2nd E, standing for engineering, may include manufacture of fire alarms, using fire-retardant fabrics to make clothing (including children clothing), and design of fire-safe cigarettes which do not burn after smoking has ceased, which decreases the risk of causing a fire. Safety is also increased by child-resistant cigarette lighters. Those measures are considered the first line of defense against

injuries because they are elements of passive prevention – may be successful in preventing injury without any action by an individual.³

The 3rd E, standing for enforcement, often requires legal regulations, for example obligatory fire alarm in each dwelling.³

Haddon matrix, due to its multifaceted approach to the issue in question, can be applied to render preventive measures for decreasing burns in children more effective. Education of parents and guardians as well as the medical personnel is very important.

There are not many studies of Polish population regarding the prevention from burns in children, thus the continuation of the commenced multi-center studies about the subject seems valid.

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