Review Paper

Adverse Effects Associated With Physical Restraint

Wanda K Mohr, PhD, RN, FAAN[1], Theodore A Petti, MD, MPH[2], Brian D Mohr, MD[3]

Objective: Restraint use is not monitored in the US, and only institutions that choose to do so collect statistics. In 1999, investigative journalists reported lethal consequences proximal to restraint use, making it a life-and-death matter that demands attention from professionals. This paper reviews the literature concerning actual and potential causes of deaths proximal to the use of physical restraint.

Method: Searching the electronic databases Medline, Cinahl, and PsycINFO, we reviewed the areas of forensics and pathology, nursing, cardiology, immunology, psychology, neurosciences, psychiatry, emergency medicine, and sports medicine

Conclusions: Research is needed to provide clinicians with data on the risk factors and adverse effects associated with restraint use, as well as data on procedures that will lead to reduced use. Research is needed to determine what individual risk factors and combinations thereof contribute to injury and death.

Information on author affiliations appears at the end of the article.

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Clinical Implications

- Clinicians should obtain baseline cardiovascular evaluations of psychiatric patients to establish any preexisting cardiac conditions.
- Clinicians should consider risk factors when restraints are used.
- One-to-one observation should be the clinical standard while patients are in restraints.

Limitations

- The extent to which restraints can be classified as therapeutic interventions is questionable.
- The extant literature on restraints does not represent a basis upon which clinicians can continue to use restraints uncritically.
- The psychiatric literature has given little attention to the causes of death or injury resulting from physical restraint.

Key Words: *physical restraints, adverse effect, complications, seclusion, death*

As employed in psychiatric settings, physical restraint is a security measure designed to protect patients and staff. However, the extent to which restraints can be classified as therapeutic interventions is questionable: their efficacy as therapeutic measures has not been empirically demonstrated in outcome studies (1). Use of physical restraint cuts across all ages and types of health and human service settings. Reports of lethal consequences proximal to their use raise the issue to a life-and-death matter that demands attention from professionals.

Definitions of restraint range widely, from the concrete and objective definition of the Health Care Financing Administration (HCFA) to the looser definition of the Joint Commission on Accreditation of Health Care Organizations (JCAHO) (2). Broadly, "restraint" refers to physically restricting movement. Most commonly, it refers to confining the limbs on a specially designed bed (that is, "4-point" or "5-point" restraint), but it can also mean restraining patients to a chair, limiting arm or leg movement ("ambulatory restraint"), or restraining the whole body with a camisole or straight jacket. Physical holding and placing children in a papoose are also included in definitions of restraint. Despite their ubiquity in psychiatric settings, the prevalence and use of restraints are not monitored in the US, nor are they reported to any oversight agency. Only institutions that choose to do so collect statistics

on restraint use (3). Without such crucial data, the risks from the use of restraints cannot be evaluated empirically.

Legislation passed in 1999 requires US facilities to report deaths proximal to restraint use. Following this legislation, hospitals reported more than 2 deaths a month. The JCAHO also has a process whereby hospitals can report such sentinel events as death and injury, but this is voluntary (3).

Some reports suggest that 37.5% of child or adolescent inpatients may be secluded or restrained in some manner (4). In children, restraint usually occurs as "therapeutic holds"; a JCAHO sentinel events survey documents children dying during such holds (2). A 1999 US government report "found conclusively that children are especially targeted by facility staff for this unsafe practice (restraints), and are at greater risk of injury and death" (3).

The practice of restraint puts both patients and staff at risk for injury and death (2). Moreover, restraints can be traumatic even when they do not result in injury and death (1,5–7). The 1998 *Hartford Courant* investigation noted that, between 1988 and 1998, 142 reported deaths in mental health settings were connected to the use of physical restraint (8). Those who died were disproportionately young children. The *Courant* observed that deaths occurred in all 50 states and that the statistics represented only reported documented deaths. This newspaper exposé, as well as a *Sixty Minutes* documentary of conditions in some psychiatric facilities, prompted a Congressional investigation that confirmed the risks inherent in the use of mechanical restraints (3).

Zusman lists patient actions, improperly applied restraints, and restraint failure as causes of physical injury or death associated with restraint use (2). The types of physical injury or death he lists include dehydration, choking, circulatory and skin problems, loss of strength and mobility, incontinence, and injury from other patients (2). Even though empirical studies associated with restraint use are lacking, professional organizations have recently taken strong stands against restraint use. In this brief review and discussion, we bring together some diverse sources of literature concerning the demonstrated adverse effects related to restraint use in various settings. While acknowledging the dearth of empirical studies and published post mortem data, we also hypothesize about physiological mechanisms that may be implicated in restraint-related death. Finally, we offer observations on the socialization and education of professional caregivers on this subject.

Restraints and Their Hypothesized Role in Death

With a sparse psychiatric literature, no consensus exists concerning the causes of death and injury associated with restraint use. Related studies are found in the forensic, geriatric, and emergency literatures. With a single exception, a review of the psychiatric literature yields scant discussion of the physiological mechanisms or the cascade of physiological responses associated with states of emotional hyperarousal that may compromise patients physically (9). In 1998, the JCAHO *Sentinel Event Alert* reviewed 20 restraint-related deaths (10). It found that 40% of deaths were caused by asphyxiation, while strangulation, cardiac arrest, or fire caused the remainder. Cardiac arrest resulting in death has many causes. The JCAHO report did not elaborate on the causes of cardiac arrest in the absence of preexisting cardiac conditions, and the etiology remains a subject of speculation. Death from asphyxiation was determined to be related to identifiable factors, such as putting excessive weight on the back of the patient in a prone position, placing a towel or sheet over the patient's head to protect against spitting or biting, or obstructing the airway when pulling the patient's arms across the neck area. These are maneuvers employed in "takedowns" by staff trained to restrain combative patients. The *Hartford Courant* listed the reported causes of restraint- or seclusion-related death as asphyxia, cardiac complications, drug overdoses or interactions, blunt trauma, strangulation or choking, fire or smoke inhalation, and aspiration (8).

Restraint Asphyxia

Asphyxiation, the most common cause of restraint-related death, is termed "restraint asphyxia" in the forensic and emergency literature (11). Most reports concern adults who often, but not exclusively, have been in police custody. The deaths frequently involve the victims' use of alcohol or some illegal substance. Although psychiatric inpatients generally are not under the influence of such intoxicants, many are prescribed central nervous system depressants as well as other psychotropic medications.

To explain unexpected deaths of apparently healthy persons in restraint, Reay and others studied the physiological effects of positional restraints following exercise (12). Measuring arterial oxygen saturation and heart rates of 10 normal subjects, they found that 9 of the 10 experienced prolonged recovery from exercise under conditions of prone positional restraint. The underlying mechanism was unclear. Potential causal factors identified include restriction of thoracic respiratory movements, airway compromise, and the release of catecholamines during physical exertion. These adverse effects occurred in normal, healthy subjects. We believe that the effects may be even stronger in our compromised psychiatric population. Reay noted in his paper that autopsy findings to support a diagnosis of restraint asphyxia could be meager to nonexistent, with no typical pathological findings on autopsy (11).

Determination of restraint asphyxia must be made based on the historical events surrounding the physical struggle.

Positional asphyxia occurs when the body's position interferes with respiration. In the forensic literature, death from positional asphyxia was found to occur when individuals were placed in a position that did not allow adequate breathing, most often a prone position. This may involve a restrictive or confining position, a simple flexion of the head onto the chest, a partial or complete external airway obstruction, or neck compression. Persons who later died were unable to disengage themselves from the physical or mechanical restraint (13–15). Reay and others also reported fatal positional asphyxia occurring in individuals who were transported in a prone position by law enforcement personnel (13,14). In each case the final fatal event was hypoxia resulting from mechanical interference with respiration. When scholars reviewed 63 cases of asphyxia death following restraint use in individuals ranging in age from 26 weeks to 98 years, they found that restraints had been properly applied in 57 cases (16). This finding suggests that restraints pose an inherent danger to patients even when proper techniques are used. Although fatal positional asphyxia has been documented in adults, it has not been documented in children. However, it is probable that small size alone is a significant factor increasing children's susceptibility to death by this mechanism.

Reay and others also investigated deaths resulting from neck compressions. Neck holds are a commonly employed law enforcement technique used to subdue suspects resisting arrest or to control combative prisoners (17,18). Pressure applied in one such neck hold is intended to impede blood flow in the carotid arteries. Although there may be compensating collateral circulation, occlusion of carotid blood flow can produce carotid sinus stimulation resulting in bradycardia and potential cardiac arrest (17,18). In the second type of neck hold, the intent is to occlude the airway itself by forearm compression collapsing the trachea. As individuals try to free themselves, their struggle strengthens the force around their necks. They become further agitated when they cannot breathe, thus increasing demand for oxygen and intensifying the force even more. Death can result from cardiac arrest secondary to hypoxia. Although Reay's research has primarily involved deaths and injuries in law enforcement situations, it does have implications for psychiatric populations (for example, a patient at the Manhattan Psychiatric Center died proximal to a "takedown.") Cause of death was determined to be asphyxia by neck compression (19).

Death by Aspiration

JCAHO posits that, while restraining patients in the prone position may predispose them to suffocation, restraining patients in a supine position may predispose them to aspiration (9). Aspiration can occur when persons have decreased levels of consciousness, either as a result of their illness or secondary to medications. Supine positions, during which patients are rendered immobile in conjunction with decreased or altered levels of consciousness, interfere with their ability to protect their airway. Death occurs as a result of asphyxia, acute pulmonary edema, or pneumonitis (20). At present, both supine and prone positions are recommended by various aggression- management programs. However, no data are available that speak to the relative safety of one position over the other.

Blunt Trauma to the Chest

Blunt trauma to the chest (BTC) has not appeared in the literature as a potential risk of the restraint process, although it was suggested as causing death in a recent legal case reviewed by the first author. In that case, a child sustained a blow to his chest during the restraint and died. There were no findings on autopsy. Commotio cordis, a cardiac arrhythmia secondary to myocardial concussion during the vulnerable phase of cardiac electrical repolarization (just prior to T-wave peak) resulting from BTC, has been reported to cause sudden death. Although rare, deaths have been reported, primarily in children, and are thought to be related to the child's thin chest wall. When sudden death is owing to BTC, no morphological changes are seen in the myocardium, and the diagnosis cannot be made by autopsy. Rather, the diagnosis must be based on circumstantial evidence, the temporal sequence of events, eyewitness accounts, and indication of BTC. Commotio cordis deaths have been reported most often in young athletes experiencing sudden BTC (for example, being hit by a baseball). A recent study, however, demonstrated that cases occurred across a diverse spectrum of events, including many in the broader context of life unrelated to sports (21,22).

Catecholamine Rush

Massive release of adrenal catecholamines may occur in patients who are involved in escalating agitation, struggles with staff members, and "takedowns" to the ground or who are carried elsewhere and secured with restraints. This catecholamine outpouring may sensitize the heart and produce rhythm disturbances (23). Behavioural arousal and psychological stress have been shown to induce malignant cardiac rhythm disturbances (23–25).

Neural and psychological factors have been implicated as risk factors for ventricular arrhythmias and sudden death (24–26). Neural integration of body functions takes place through a complex system of feedback loops when information from within and without the organism is taken in and catalogued by the brain. These pathways play a major role in causing sudden death in persons who find themselves in perilous situations.

Moreover, the situations need not be perilous to precipitate cardiac arrhythmias (26). Lown and colleagues identified psychic stress as a mediating factor for advanced cardiac arrhythmias, and it has been suggested that emotional extremes are triggering mechanisms for sudden cardiac death (24–26).

Deaths associated with extreme physiological exertion differ somewhat. Emergency medicine physicians recently reported cases of profound metabolic acidosis in cardiac arrest associated with use of restraints. In a sample of patients who died—most, but not all of whom had been under the influence of cocaine—the recorded blood pH was 6.25. The common variable was extreme exertion from either fleeing or fighting vigorously while being subdued. The authors speculate that psychosis and delirium, including drug-induced delirium, alter pain sensation and may thus render patients capable of exertion far beyond their normal capacity, leading to maximal sympathetic discharge and catecholamine depletion (27). By provoking further struggle, physical restraint results in overwhelming acidosis. Acidosis of this magnitude should trigger physiologic compensatory mechanisms, but the prone restraint position may limit reflex compensation (27).

Psychotropic Medications

The potential for adverse effects in the restraint process may be increased for patients receiving psychotropic or other medications as well as street drugs. Sudden deaths of psychiatric patients have been reported for many years (28) and attributed to a syndrome of excited delirium. Sudden death occurs with the onset of an abrupt change in clinical status (26). The association of psychotropic medications and cases of sudden death (29–34) is controversial (35). Treatment with phenothiazines is an overrepresented finding among psychiatric patients who die suddenly (36). In one study, the risk of sudden death for individuals receiving neuroleptics was 2.39 times greater than for nonusers (36).

Major cardiac effects, including sudden death (30), are documented for many commonly prescribed psychotropics (36–39). The prolonged QT interval syndrome has been associated with psychotropic medications for some time (40,41). Over 40 marketed drugs and an equivalent number of drugs under development have been found to block potassium channels, prolong the QT interval, and sometimes induce torsades de pointes, or polymorphic ventricular tachycardia, in which QRS complexes vary from beat to beat and heart rates vary from 150 to 250 beats per minute, creating a significant potential for lethal ventricular fibrillation and subsequent death (40,42). A relatively rare drug-induced event, its incidence can be as high as 2% to 3% with some medications (40,42).

Tricyclic antidepressants increase the QT interval and are associated with sudden deaths (43–45). Other psychotropic medications are known to prolong QT interval in patients without history or manifestation of cardiac disease (44,45). Many psychoactive agents with anticholinergic properties that are used in psychiatric settings are also potentially toxic. Children in particular are more susceptible to the adverse effects of anticholinergic drugs (46). These medications systemically attenuate normal body cooling mechanisms. In children and in the elderly experiencing extreme agitation while struggling with staff and against restriction, the ability to discharge or release the heat generated by this increased activity is weakened. Given sufficient other conditions, (for example, serum medication level, dehydration, and improper room ventilation), restraint may lead to serious and potentially life-threatening hyperpyrexia.

Rhabdomyolosis

Most cases of rhabdomyolosis occur in otherwise healthy persons. The breakdown of muscle cells results from strenuous exertion, infections, intoxication, deficiency states, prolonged stasis, or trauma (47–49). Common precipitants of life-threatening rhabdomyolosis are physical exertion (exercise rhabdomyolosis [ER]) and alcohol abuse (49,50). Military and sports physicians report that many forms of exertion cause ER (50–56). Extreme exertion, hot weather, and being physically unfit or unaccustomed to climactic conditions are implicated as major risk factors. Rhabdomyolosis is also a critical feature of neuroleptic malignant syndrome (NMS) and is associated with neuroleptic and dopamine-related medications (57). Unexplained deaths associated with restraint use may be explained by ER. Rhabdomyolosis in a man suffering from an acute manic episode and medicated with lorazepam was attributed to excessive exertion and dehydration (58). Similar factors occurred in other deaths attributed to rhabdomyolosis. Hyponatremia, benzodiazepines, chlorpromazine use, and full-sheet restraint contribute to development of rhabdomyolosis (58,59). Since definitive evidence exists that rhabdomyolosis plays some part in reported deaths not resulting from positional asphyxia or neck compression, it represents a consideration in the care of severely ill psychiatric patients; most specifically, those who are experiencing acute delirium, intoxication, or both.

Thrombosis

Fatal pulmonary embolism and thrombophlebitis have been reported in the literature as complications of severe catatonic states during which patients are immobile for long periods of time (60,61). This suggests that immobilization may be a risk factor for both injury and death (62). Recently, prolonged physical restraint has been reported to be the proximal cause of thrombosis, with a fatal outcome in 1 case (60).

Psychological Effects

The scant literature concerning psychological and cognitive effects of physical restraint suggests that it may be perceived as punitive and aversive, with the potential for traumatic sequelae. Women having histories of childhood sexual abuse recalled the experience of being physically restrained as representing a reenactment of their original trauma. The restraint experienced years later was associated with traumatic emotional reactions, (for example, fear, rage, and anxiety) (7). Likewise, children and adolescents who had been restrained during psychiatric hospitalization reported nightmares, intrusive thoughts, and avoidance responses resulting from their restraint experiences, as well as marked startle responses associated with being held in benign and nonthreatening situations. They also reported painful memories and fearfulness at seeing or hearing others being restrained and a mistrust of mental health professionals (6). Five years later, they continued to experience intrusive thoughts, recurrent nightmares, avoidance behaviours, startle responses, and mistrust (63).

Educational Recommendations

Several professional organizations, JCAHO, and HCFA have issued standards, practice parameters, and practice recommendations for managing aggressive behaviours and applying restraint. All have essentially the same elements and recommend similar approaches. They do not stress the need for ongoing professional oversight to preserve the investment that has been made in educating staff. However, such oversight is crucial, given the propensity for new learning in behavioural procedures to be abandoned shortly after training or consultation (64). Basic education of professional staff who order restraints is another missing element in position statements and recommendations. Few professional publications consider the proper approach to actually implementing restraint procedures in light of potential adverse effects associated with their use. Only Lion and Soloff provide a general description of the structure and process by which restraint should be conducted and include precautions regarding select high-risk factors (65). An examination of psychiatric texts, substance abuse and chemical dependency texts, and psychiatric mental health nursing texts shows that, although restraint is discussed as an intervention for violent behaviour, it is discussed in very general terms (66–78). No text specifically discusses the dangers inherent in restraint use or even alludes to potential injury, death, or trauma. This oversight by educators represents a failure to communicate the serious nature of restraint use and should be corrected. *Kaplan and Sadock's Comprehensive Textbook of Psychiatry* does discuss the legal implications of restraints and their use in the elderly (79). The silence of nursing texts on dangers and potential mortality is especially disquieting, since nursing personnel carry out restraint procedures and are responsible for monitoring restrained individuals. Overall, textbooks should treat the subject of restraint in more detail, discuss the characteristics of individuals who are most at risk for injury or death, convey the associated adverse effects, and provide practical advice on how to recognize potentially dangerous situations.

Research Recommendations

Authors writing about physical restraint and death generally agree that the causes of mortality are complex and multifactorial. Teasing out the variables or combination of variables responsible for death proximal to restraint is a daunting challenge that will test researchers' methodological creativity. Compared with the general population, rates of sudden death are reported to be higher among recipients of mental health services for several reasons, including general neglect of health and increased rates of damaging personal habits (for example, smoking, alcohol and other substance abuse, and poor diet) (80–82). The role of concomitant medication with cardiac effects, of preexisting conditions including excited delirium, and of intense agitated states that could potentially contribute to injury or death must be determined. Psychotropic medications have been identified historically as associated with lethal outcomes for patients. Position and immobilization of patients during restraint and factors associated with the environment itself, such as inadequate staffing ratios and lack of staff training, must be considered in trying to understand resultant injury and death. No research has yet been conducted to determine what factors, under what conditions, and in what combinations lead to injury and death. Research is urgently needed to address the following issues: 1) risk factors associated with death proximal to physical restraint of patients, 2) independent effects of these risk factors on death proximal to physical restraint, 3) interactive effects of these risk factors on death proximal to restraint, and 4) cumulative effects of these risk factors on death proximal to physical restraint.

Recommendations for Practice

Apart from more thorough education and training, several practice precautions seem prudent. First, even though the association of psychotropic medications and sudden death is circumstantial, their documented cardiotoxicity warrants careful administration in emergency situations (36,42,83,84). Psychiatric units should be equipped to deal with potential cardiovascular emergencies, and clinicians should be competent to recognize potential cardiac problems and have current certification in cardiopulmonary resuscitation. Given the limitations placed by regulators on the use of physical restraints and the potential for expanded use of chemical restraint, clinicians must become aware of the risk for untoward and lethal effects of large dosages of psychoactive medications.

It may be difficult to obtain a baseline cardiovascular evaluation of patients who present in an excited and violent state in emergency rooms or inpatient units, but to establish any preexisting cardiac conditions, an evaluation should be obtained as soon as they are calm. Patients routinely taking psychotropic medications and at risk for restrictive interventions may warrant periodic monitoring of their cardiovascular functioning, including the QT interval.

Since the agitated state itself may contribute to death when restraints are applied and patients continue to struggle against them, patients should never be left alone, particularly if they have been medicated. Documented risk factors, such as obesity and intoxication with drugs or alcohol, should be taken into account when restraints are applied; prone positions in which excess abdominal fat might compromise respiratory functioning should be avoided (85,87). Given the reports on ER, clinicians may also consider measuring temperatures, creatine phosphokinase (CPK), and electrolyte levels in restrained patients receiving psychotropic medications and experiencing prolonged mania.

Although all restrained patients should be carefully monitored, one-to-one monitoring should be the standard when such risk factors are present. Staff applying restraints must understand that struggling against restraint may not simply be oppositional. Because it may represent a natural response to the subjective feeling of being unable to breathe, correct assessment of these situations is critical. The third author has encountered several clinical situations in which staff members attributed a patient's struggles to belligerence, when they were in fact agitation caused by hypoxia. Typically, as patients' struggles intensify, staff increase the pressure of their hold until patients stop resisting. When a patient ceases struggling, staff or police assume that patients have calmed down or that they are "playing possum." Reports indicate that restrained individuals at that point have either been left alone or staff members have intensified holds for extended periods when struggling persisted. Too often, however, calm behaviour has indicated that restrained patients are in respiratory arrest or have died (86–88). Subsequent resuscitation has been ineffective. This underscores the need for careful application of restraint procedures and ongoing monitoring of patients by well-educated and well-trained personnel.

When implemented judiciously and carefully by well-trained staff under clearly defined circumstances, restraints employed in treating acutely violent or agitated patients, children, and adolescents can lead to improved patient care and outcome (2,89–91). Increased emphasis on preventing restrictive interventions through staff training and patient education is likely to reduce the incidence of adverse effects secondary to restraint use. Studies have demonstrated that espousing the strategies in the professional and JCAHO guidelines successfully reduces or eliminates restraint use (92,93). Interventions include promoting self-management for some children and adults with poor self-control and providing protection from acutely aggressive patients within the milieu.

There is a dearth of studies to support the efficacy or necessity of restraining children and adolescents or to support setting the boundaries or criteria to define conditions for restraint across patient populations (89,94). There is no question that physical restraint is at times required for the safety of both patients and staff. All 3 authors have had to order or initiate restraint procedures when patients were clearly unresponsive to alternative measures. However, most staff injuries and many patient injuries in hospitals and residential centres actually occur during the process of seclusion or restraint (90). Reasonable standards for the appropriate employment of restraint, including specific inclusion and exclusion criteria, can be determinined. This effort must be tempered, however, by the cautionary note that rigid guidelines should be avoided and clinical judgment should play a role (90). Clinicians may be faced with choosing the lesser evil when confronted, for example, with a patient on multiple medications experiencing acute psychosis or delirium and having additional risk factors such as obesity. Given the potential adverse effects of physical or mechanical restraint, studies in this area and guides for appropriate management of such situations are needed. Of greatest concern is the lack of information in clinical texts, which suggests that the dilemma is rarely considered in the education of psychiatrists and nurses. This leaves professionals to learn while practising, a situation that depends upon the vagaries of the institutions in which they practise.

Conclusion

This article presents an overview of the hypothesized and established complications of physically restraining psychiatric patients. Despite ubiquitous use in psychiatric settings and wide media coverage and increasing pressure to regulate restraint use, the psychiatric literature has given little attention to the causes of death or injury sustained as a result of physical restraint. The extant literature on restraints does not represent a body of knowledge upon which clinicians can base continued uncritical use of this quasi-therapeutic and security measure. Research is needed to provide clinicians with data on both the risk factors and adverse effects associated with restraint use, as well as data on procedures that will reduce these coercive measures. Research is also needed to determine what individual and combined risk factors contribute to injury and death. Finally, research is needed to determine efficacious and effective alternative measures to restraint. There are many programs designed to train staff members in deescalation skills. These need to be subjected to empirical scrutiny so that

clinicians can have safe and effective measures to deal with violent clinical situations.

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[1]Associate Professor, Psychiatric Mental Health Nursing, Rutgers University, College of Nursing, Newark, New Jersey.
[2]Arthur B Richter Professor of Child Psychiatry, Indiana University School of Medicine, Indianapolis, Indiana.
[3]Cardiologist, Permian Cardiology Associates, Midland, Texas.
Address for correspondence: Dr WK Mohr, 10 Knapton Hill Rd, Mendham, NJ 07945
e-mail: mohr@nightingale.rutgers.edu

Résumé : Effets indésirables associés à la contrainte physique

Objectif : Le recours à la contrainte n'est pas surveillé aux É.-U., et seules les institutions qui la choisissent recueillent des statistiques. En 1999, des journalistes d'enquête ont rapporté des conséquences fatales attribuables à l'utilisation de contrainte, en faisant une question de vie ou de mort qui exige l'attention des professionnels. Cet article examine la documentation concernant les causes réelles et potentielles des décès attribuables à l'utilisation de contrainte physique.

Méthode : À l'aide des bases de données électroniques Medline, Cinahl et PsycINFO, nous avons recherché les domaines suivants : médecine légale et pathologie, sciences infirmières, cardiologie, immunologie, psychologie, neurosciences, psychiatrie, médecine d'urgence et médecine sportive.

Conclusions : Il faut d'autres recherches pour fournir aux cliniciens des données sur les facteurs de risque et les effets indésirables associés à l'utilisation de contrainte, de même que des données sur les procédures qui réduiront cet usage. Il faut aussi des recherches pour déterminer quels facteurs de risque individuels et quelles combinaisons de ceux-ci peuvent contribuer à des blessures et à des décès.