Annex M – MEDICAL ASPECTS OF THE MOSCOW THEATRE HOSTAGE INCIDENT

M.1 INTRODUCTION TO THE MOSCOW THEATRE HOSTAGE INCIDENT

In Moscow on **Wednesday** October 23, 2002, at about 21:00 more than 800 people were taken captive by some 50 Chechen rebels in the 1,100 seat "North-East"[1]-musical theatre. Only a few actors and theatre workers managed to escape. Dressed in camouflage and equipped with firearms, the rebels drove up with three cars, entered the theatre during the second intermission, and proceeded to the stage shouting: "We are Chechens, we are at war here!" They called themselves the "29. Suicide Division".

All but the commander, Movsar Barajew, wore black masks, had handguns, and wires and switches to large quantities of explosives around their waists. Thirty-two men and eighteen women hurried to deposit about thirty packages of explosives at the pillars and in the middle of Row 15 inside the theatre. The rebels threatened to kill everyone inside the theatre unless Russia ended the war in Chechnya. A female musician down in the orchestra, who argued, was executed immediately. Although the Chechen militants agreed to release some of the hostages (children under age 13, foreigners, and a pregnant woman) during the first couple of days, there were no attempts at negotiation by the Russian authorities.

Thursday, October 24, Al Dshasira broadcasted a typical "confessor video" of the hostage takers, which gave President Putin the possibility, to declare them "international terrorists".[2] The occupiers carried a mobile TV and a Laptop, so they had access to news reporting and other information from outside the theatre.

On Friday, October 25, U.S. President George W. Bush, in the company of a host of foreign leaders, offered firm support to Vladimir Putin during the hostage crisis. Bush telephoned Putin and offered unspecified help in freeing the hostages.[3] On that same day, representatives of the U.S. special services met with a deputy director of the FSB to discuss the situation. Representatives of the special services of Great Britain, Germany, Turkey, France, Switzerland, and Japan also attended this meeting[4]. At 10:40 p.m. that same evening, "the head of the MVD of Russia, Boris Gryzlov, and the director of the FBI, Robert Muller, agreed to work together under a regime of constant communication. Muller proposed to send to Moscow American specialists on antiterrorist activity and specialists in the sphere of using special technical means"[5].

M.1.1 The Rescue Begins

On Saturday, October 26, at 5:20, 40 minutes before expiration of their last ultimatum, the terrorists began to shoot more hostages[6].

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[1] "North-East" is a romantic musical playing during Soviet days, the theater is situated in Dubrovka, suburb of Moscow, 5 km from the Kremlin.

[2] ARD-Studio Moskau 2002.

[3] Chechnia Weekly, Vol. 3, Issue 32, October 28, 2002.

[4] Polit.ru, October 26, 2002.

[5] Newsru.com, October 26, 2002.

[6] Theater of War: Yuri Zarakhovich/Moscow ©TIME: August 25, 2003: Olga Chernyak, a journalist who was among the hostages.

Just after 5:30 a.m., Anya Andrianova first noticed the strange smell inside the theatre. Like most of the other hostages and many of the Chechen terrorists holding them captive, she was sprawled across an auditorium seat trying to get some sleep. Alarmed by the odour, she spotted gas, eerily visible as it seeped through the air-conditioning vents and rose from the floor. Terrified that the assault on the theatre had begun, Andrianova's friend used her mobile phone to call Ekho Moskvy's early morning radio show. "They are gassing us!" she screamed, her voice shrill with panic. "All the people are sitting in the hall. We beg not to be gassed!" Taking the phone from her friend, Andrianova pleaded with the host "We see it, we feel it, we are breathing through our clothes. Please give us a chance. If you can do anything, please do." A moment later radio listeners heard gunshots, and then Andrianova screamed: "That's it! We are all going to be blown up. Our government has decided no one should leave here alive."[7]

Another hostage later gave evidence that she saw "a terrorist sitting on the stage jumping up and trying to put on an NBC mask. He cramped, fainted and went down".[8] "Than I noticed that everybody around me relaxed and started snoring."

An unidentified anaesthetic "gas" was used and the hostage takers inside the hall were unable to act or to ignite their explosives. Another lucky reason for the failure of the terrorists to act might be that 5 of the leaders at that moment were in the first-floor stage-control-room watching the video recorded by the permanent camera in the theatre of their hostage taking on Wednesday. So, perhaps, nobody was in the hall to give orders to ignite the explosives.[9] The "North-East"-Musical Director said the terrorists liked the musical; maybe he talked them into watching it on video.

At 6:23 a.m., uniformed forces smashed through the theatre's glass front, stormed the theatre without wearing NBC masks, and began igniting flash-bang grenades[10]. In the Newspapers and media, different groups were named: ALPHA Antiterrorist Specialists[11], Russian Special Forces[12], Russian Special Police Units[13], nd Spetsnaz-Soldiers[14]. (Identification of those involved is important for legal reasons.)

Within 7 minutes, the rescuers shot most of the terrorists who had not been affected by the gas, including their 27-year-old commander, Movsar Barayev, and those were anaesthetized; only 3 terrorists lived to be arrested[15].

About thirty explosives, among these a 50 kg TNT bomb, were found in row 15 in the middle of the hall. Later it was stated that the terrorists had brought in over two tons of various explosives, but there is no firm evidence that the packages were indeed loaded with explosives at all.

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[7] Theater of War: Anya Andrianova and her girlfriend called the Moscow breakfast-radio Ekho Moskvy. ©TIME: August 25, 2003.

[8] Der Spiegel, 26.10.2002: Sturm auf das Moskauer Theater.

[9] ARD-Studio Moskau 2002.

[10] arte, 30.09.03, 20:45 – 21:35: "Es waren mehrere Explosionen zu hören."

[11] Der Spiegel, 26.10.2002.

[12] The Pharmaceutical Journal, Vol. 269, 723-724, November 16, 2002.

[13] Center for Nonproliferation Studies (CNS): Moscow Theater Hostage Crisis, November 4, 2002.

[14] Chechnia Weekly, Vol. 3, Issue 32, October 28, 2002 and
Oct. 28, 2002: http://www.timeeurope.com/magazine/2002/1104/cover/story.html

[15] Der Spiegel, 26.10.2002 and ©TIME: Theater of War. August 25, 2003.

M.2 MEDICAL ASPECTS OF THE RESCUE

First impression reports indicated that during their days (58 hrs) of captivity, the hostages were in constant fear for their life, without food or beverages, and in the odour of their own excrement, which had to be deposited in the orchestra pit. After the rescue, a few hostages stumbled out of the building on their own, but most had to be carried out. Unconscious hostages were carried unprofessionally by policemen or soldiers by their hands and feet or like pig-halves over the shoulders or lying on their backs on litters. No resuscitation or intubations were sighted. Many unconscious hostages were deposited without any assistance on the pavement in front of the theatre in the cold and rain, bodies one over another.

Doctors and medics arriving at the scene were not told that the hostages had been gassed, but were not provided with any antidote. The order for ambulances to proceed to the theatre came 45 minutes after the beginning of the operation, the result being that many hostages had to be taken to hospitals in buses, microbuses, or cars. Once loaded, some buses remained in place for over an hour before leaving for medical facilities; no patient assistance was provided during this time. In one case, thirty hostages were put in a twelve-seat military microbus, and a 13 year-old girl was crushed under other bodies in the aisle and died en route. Some 450 of the rescued were sent to 8 different hospitals across the Russian capital and treated.

Few expected the siege to end through diplomacy; the rebels had shown no interest in negotiating, and Putin would not capitulate. The attack on the theatre had all the hallmarks of a typical Chechen operation: daring, ruthlessness, ambitious and totally lacking an exit strategy. The Special Forces had done their work. The theatre was shielded by police and no information was given to the hospitals, to the relatives, or to the public. President Putin was seen on TV in a white smock in a hospital and showed his emotion.

Not only the refusal to negotiate but the nature of the rescue effort suggested that the storming of the theatre was undertaken to destroy the terrorists for political reasons, and that saving the lives of the hostages had a low priority. Although the Moscow health authorities had days to prepare for the aftermath of the rescue, over one hundred persons who died from “gas poisoning” or other causes could have been saved if the rescue effort had been properly organized.[16]

First Aid and rescue chain Problems: Primary care, resuscitation, ventilation, infusions, administration of antidotes, transportation, and intensive care seem to have been excluded from operational planning. The traditional “casualty categories,” could have adapted and used. he sequence is normally (1) Determine Priority of Treatment; (2) Triage; and (3) Transportation. Especially in a Mass Casualty Scenario, triage and actual stating the Priority of Treatment on site are fundamental procedures and have to be carried out by the most experienced physician on site. A mass casualty situation may be defined as a situation in which the number of casualties presenting cannot be managed by normal methods and facilities. As a consequence, medical triage is done to ensure that “as many patients as possible will get the treatment as needed in time, and at the right place”. The agreed NATO categorisation of casualties is (according to STANAG 2879):

- Group 1: Immediate Treatment: Provide acute emergency life saving therapy; overcome respiratory obstruction; ventilate; restore heart action; give i.v. infusion; place in stabilized resting position.
- Group 2: Delayed Treatment: For those who can tolerate it, delay special treatment such as time-consuming major surgery; stabilize respiration and heart action; stop haemorrhaging; administer i.v. fluids; splint; provide pain relief; provide transportation to an adequate treatment facility.

[16] David Satter: Center for Citizen Initiatives: A Letter from Moscow, Summer 2003.

- Group 3: Minimal Treatment: For those with relatively minor injuries who can effectively care for themselves or who can be helped by untrained personnel; carry to waiting area; provide calming reassurance.
- Proper preparations for the rescue (Mass Casualty Management) should have been done according to the preview of the possible scenarios within the tactical plan. Preparation of medical rescuers and medical teams with suitable supplies of antidotes is essential. The Medical Services of the Forces and their logisticians, could have organised the necessary medical facilities nearby the theatre. Hundreds of physicians and qualified medical assistants could have been readied, and if deemed safe, rushed into the theatre for first aid and resuscitation, at least two per person in the auditorium.

In case of explosions and damage to the theatre, transportation lines had to be cleared. Special search and rescue teams with trained dogs and electronic devices should have been in close vicinity. Mobile intensive care facilities should have been arranged nearby in a protected area with hundreds of places prepared for qualified antidote therapy, resuscitation, and first surgical treatment.

Facing an emergency situation involving more than 800 persons would have needed an intensive preplanning and the will to put it in action.

In Moscow there was no rescue chain organized. Many of the unconscious hostages could have been saved by restoring respiration and putting them into a stabilized resting position. Artificial ventilation could have reduced the effect of the inhaled anaesthetic (see below for further discussion of this point).

M.3 WHAT KIND OF "INCAPACITANT" WAS USED?

M.3.1 Capability

Russian Authorities have declined to identify the substance used in the rescue, so we have had to use the available evidence to deduce the answer. At first common and cheap substances were suspected, knowing about the lack of aesthetic pain relief medication in Russia. So, Nitrous oxide N_2O, Ethylene ($H_2C{=}CH_2$), Acetylene Narcylen HC≡CH, Cyclopropane (Trimethylene), CO, Aliphatic Halogens and, possibly Cyanide were prime candidates. Nitrous oxide is available in every hospital and most of the other substances are used in industry in Russia. "BZ", 3-quinuclidinyl benzylate, a Belladonna-Alkaloid, could also be a possibility as this substance is a Central Nerve System depressant that appeared to be available on both sides of the iron curtain in the 1950s; however, BZ takes hours to act and, results in delirium for days, and neither of these situations was reported in the Moscow theatre incident.

M.3.2 Eyewitness-Reports and Expert Opinions

Der Spiegel, 26.10.2002, Sturm auf das Moskauer Theatre: Correspondents of French Press Agency AFP: "When we smelled it we lay down on the floor". The "gas" spread over the hall like a fog. "I inhaled through my comforter, fainted for several times and woke up again, as if I had drunken a ton of vodka".

A teacher advised her pupils to inhale through wetted handkerchiefs before she fainted herself.

Kieler Nachrichten (KN) Monday, 28.10.02: 540 hostages suffering from "gas Poisoning" are hospitalised, 329 of them in Hospital Nr. 13.

KN Tuesday, 29.10.02: Vladimir Ryabinin, a physician from the Moscow Sklifosovsky Hospital, confessed[17], that 42 hostages were still treated in intensive care units in danger to life from gas poisoning, but that they really didn't know, what had caused the poisoning. Officially they heard about "sleeping gas," "special gas," or a "substance from the pool of incapacitants."

The Moscow newspaper Komersan suggested the substance could be a product of Cold War times.

KN Tu, 29.10.02, Page 3: Anna Politkowskaja, an observer of the Moscow newspaper The Novaya Gazeta, a specialist on Chechnya, speculated that a High Power Microwave weapon could have been used by the storming forces to disrupt the cell phone, internet connections, and other electrical device of the terrorists.

Der Spiegel, Tu, 29.10.02: Moskauer Geisel-Drama: "Policeman arrested for giving actual information from outside to the Chechens." Police later announced that they had also detained thirty "accomplices" in the area around the theatre and in other parts of the city.

Der Spiegel, 29.10.02: Moskauer Geisel-Drama: US Officials hinted, that "gas" was an opiate.

Die Welt, We, 30.10.02: The Russian Minister of Health, Juri Schewtschenko, released: "To overcome the terrorists a mixture of Fentanyl derivates was used."

Ärzte Zeitung, 30.10.02: In Moskau spricht alles für gängiges Narkosegas: Prof. Thomas Zilker gave the opinion that a common aesthetic had been used. His study of two German hostages found no evidence of cholinesterase inhibition, counter-indicating the use of a nerve agent. Both had recognized a light sweet smell and taste and immediately had fallen in a deep coma and woke up later in a Moscow Hospital.

According to press reports, some hostages in the theatre had died from gas exposure. One source close to the Kremlin said the amount of sleeping agent used was five times the normal dose.

Deutsches Ärzteblatt, 44, 1.11.2003: German expert on terrorism David Schiller estimates it could have been the chemical warfare agent BZ.[18]

Dr. Peter Hutton (The British Association of Anaesthesiologists) says, he doesn't know an anaesthetic that acts like the Moscow substance. "It's for sure a substance developed for military use only."

Western Secret Services too suggest that the Russian special services used a totally new substance that acts within seconds and is not detectable.

arte, 30.09.2003, 20:45 – 21:35: "All people around me fell asleep and started snoring at once."

Der Spiegel, Sa, 26.10.02 Sturm auf das Moskauer Theater: Toxicologists suggest that the "sleeping gas" was made of Valium.[19]

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[17] Kieler Nachrichten Tu, 29.10.02 and Time Europe Monday, August 25, 2003: Theater of War: The Chechens who dared seize a theater in Russia's capital are put down, but their cause is on center stage. BY JOHANNA MCGEARY AND PAUL QUINN-JUDGE/MOSCOW. With reporting by Yuri Zarakhovich/Moscow.

[18] arte (French/German TV), 30.09.03, 20:45 – 21:35: Eyewitness reports the aerosol had a smoky smell. BZ has to be carbonized!

[19] Valium has a much better therapeutic index than Opiate: Schiermeier, Q.: Hostage deaths put gas weapons in spotlight. Nature 2002; 420:7. Nov. 7 2002.

On Sunday, Oct. 27, reports stated it was likely an aesthetic gas, but the physicians in Moscow hospitals suspected chemical warfare agents and administered the common antidotes as used in the army.

Ken Alibek, former soviet expert on chemical warfare: Nobody really believes that Russia destroyed substances that were developed and produced in several chemical warfare programs for military purposes.

Prof. Joel Donchin, Hadassah Ein Karem University Hospital, Jerusalem: "None of the commonly used anaesthetics could have such an effect. A normal anaesthetic never could have been sufficient for such a large number of people in a tall theatre." The use of nerve gas could help to explain the bad condition and outcome of patients.

Leonid Idelmann, Head of the Israeli Association of Anaesthesiologists, assumed a chemical warfare agent too. "From my opinion the gas was based on Acetone." "This could be pointed out by the fact that the hostages immediately lost their consciousness, when the gas entered through the ventilation outlets."

Dr. Thomas Zilker, toxicologist in Munich supposed the gas was Nitrous oxide. "It has to be administered in large amounts to establish high enough concentration in the inner of the hall to cause people to fall into anaesthesia." This opinion matched well with vomiting and relatively quick wake up and relief.

Jan van Aken, Biological and chemical weapons expert in Hamburg, cellular biologist, and founder of the Sunshine-Project thinks none of the deadly well known military nerve gases were used; however, in could have been a new type of military gas. Common medical anaesthetics would have a major dosage problem.

Hansruedi Indermühle, AC Laboratory Spiez, Kanton Bern, Switzerland, thinks it was an aesthetic gas: "Hostages were told to have smelled the gas, and anaesthetic gas smells."

A German NBC expert suspected it was an old warfare agent like a Sarin derivative because many of the hostages were disrobed and recently showered, perhaps for decontamination.

Words of Russian Minister of Health Juri Schewtschenko 4 days after the event, printed in Die Welt Oct. 30, 2002, opened new perspectives: "A Fentanyl derivate was used to neutralize the terrorists." The gas used is a common anaesthetic used worldwide and "cannot by itself be called lethal."[20]

A source close to the Kremlin said the amount of agent used was 5 times the normal dose. "They're not saying what kind of gas they used, but they do say that they used too much of it to be safe."[21]

M.3.3 Conclusions Based on Eyewitness Reports and Expert Opinion

Diffusion (specific weight): "like a fog", "rising from the floor."

Odour, Taste: "light sweet smell and taste, "smoky smell"

Convulsions: were noticed in a terrorist on the stage.

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[20] Russia comes clean over gas, demands extradition of Chechen envoy. Centre for Defence Information Web site. October 31, 2002. Available at: http://www.cdi.org/russia/229-1.cfm. Accessed January 3, 2003.

[21] Time Europe Monday, August 25, 2003: Theatre of War: The Chechens who dared seize a theater in Russia's capital are put down, but their cause is on center stage. BY JOHANNA MCGEARY AND PAUL QUINN-JUDGE/MOSCOW. With reporting by Yuri Zarakhovich/Moscow.

Nausea and Vomiting: were reported (but these symptoms are very common with poisonings (~13%) and following anaesthesia.

Anaesthesia / Signs of Poisoning: tipsiness, loss of consciousness, sound sleep, and death.

M.3.4 Discussion of Possible Substances Used in the Moscow Theatre Incident

M.3.4.1 Fentanyl

Fentanyl is a synthetic Opioid and, as an analgesic, its potency is 80 times that of Morphine. Profound analgesia and unconsciousness are induced by slow intravenous administration of adequate doses (50 to 100 µg/kg body weight) of Fentanyl. Respiratory depression is shorter than by Morphine. Following intravenous administration of fentanyl, the onset of action is within one circulation time. The duration of action is approximately 30 minutes.

Fentanyl is always applied intravenously (i.v.). We found no information of its use by inhalation.

High doses induce respiratory depression and respiratory arrest, which is why controlled artificial ventilation has to be prepared and ready for use when working with Fentanyl.

The narcotizing effects of morphine derivates can be antagonized by titration with naloxone (Narcan) and Naltrexone); however, renarcotization is quite common. Given the high lipophilicity of fentanyl derivatives, redistribution from tissue stores to the central compartment may explain the recurrent opioid effect. Those effects may be potentiated by acidosis, hypothermia, and rewarming,[22] so patients have to be monitored closely for some time following anaesthesia with fentanyl.

M.3.4.2 Neuroleptics and Opioid Combinations

Neuroleptic compounds, such as the butyrophenone derivate droperidol, Dehydrobenzperidol (DHB), produce a state of quiescence with reduced motor activity, reduced anxiety, and indifference to the surroundings. Sleep is not necessarily induced. In addition to inducing neurolepsis, droperidol has antiemetic actions and enhances the effects of other CNS depressants. In case of hypovolemia it causes heavy depression of blood pressure, which must be overcome by i.v. infusions.

Neuroleptic analgesia can be converted to neuroleptic anaesthesia by the concurrent administration of 65 % nitrous oxide in oxygen.

M.3.4.3 Dissociative Anaesthetics

Some arylcycloalkylamines may induce a state of sedation, immobility, amnesia, and marked analgesia. The name dissociative anaesthesia derives from the strong feeling of dissociation from the environment that is experienced by the subject to whom such an agent is administered. Ketamine hydrochloride is supplied in solution for intravenous or intramuscular use. For the introduction of dissociative anaesthesia in an adult, Ketamine hydrochloride is administered in a dose of 1 to 2 mg/kg intravenously over a period of one minute, which equals the intramuscular injection of 6 to 13 mg/kg. A sensation of dissociation is noticed within 15 seconds and unconsciousness becomes apparent within another 30 seconds. Following a single dose,

[22] Caspi J, Klausner JM, Safadi T, et al.: Delayed respiratory depression following fentanyl anesthesia for cardiac surgery. Crit Care Med. 1988;16:238-240.

unconsciousness lasts for 10 to 15 minutes and analgesia persists for some 40 minutes. In combination with nitrous oxide, Ketamine hydrochloride can be employed for induction of anaesthesia or to produce adequate general anaesthesia.

M.3.4.4 Nitrous Oxide (N_2O)

Nitrous oxide is a colourless gas without appreciable odour or taste. It is marketed in steel cylinders as a colourless liquid under pressure and in equilibrium with its gas phase. As it is released from the cylinder, some of the liquid nitrous oxide returns to the gaseous state; the pressure in the tank thus remains nearly constant until all the liquid has evaporated. The heat required for its evaporation is obtained from the walls of the cylinder and surrounding air, with the result that the tank becomes cold. Nitrous oxide is heavier than air. (Remember the statements of the hostages: "visible Vapour", "like a fog," "rising from the floor.")

Nitrous oxide is currently used as an adjuvant during most procedures in which general anaesthesia is employed. Analgesia equivalent to that produced by morphine follows the inspiration of 20% nitrous oxide; some patients loose consciousness when breathing 30% nitrous oxide, and most will become unconscious with 80%. A concentration of not less than 30% of oxygen is wise, and therefore, not more then 70% nitrous oxygen should be employed. There is very rapid onset of and recovery from effects. Also, Nitrous oxide frequently is used as a carrier for potent, non-flammable volatile anaesthetics such as halothane.

M.3.4.5 Halothane (Fluothane)

In combination with nitrous oxide, Halothane dose can be reduced compared to Halothane alone. The myocardial depressive effect of Halothane thereby is reduced.[23] Halothane is a clear liquid, its odour similar to Chloroform. It's a very potent anaesthetic but with only a low therapeutic index. When a person is overdosed, cardiac and respiratory arrest occurs simultaneously. That is why a special vaporizer is absolutely necessary for adequate dosage. Halothane uptake into the body is slow and only reaches desired effect after several minutes, which is the reason it is combined with nitrous oxide for initiating narcosis.

Fentanyl and Halothane in combination add in their respiratory and depressive action. A high-dose combination of both compounds might be considered a serious misjudgement[24]. It was curious that traces of halothane were found in the blood and urine specimens of two German hostages two days after their liberation, but no fentanyl or evidence of nerve agents was found.[25] However, halothane derivatives are in wide use in contemporary medicine for anaesthesia. Perhaps what was detected was a "Flurans", such as "Sevofluran" in nitrous oxide.

M.3.4.6 Fentanyl Derivates

There is abundant evidence in the literature on animal medicine of the development of fentanyl derivates for narcoses of large animals like bears, chimpanzees, domestic horses, elks, elephants, grey seals, grey wolves, gorillas, rhinoceroses and wood bison[26] (see Table M-1).

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[23] Stöcker, L.: Narkose. S. 30. Georg Thieme Verlag, 1969.

[24] Van Damme, B.: Moscow Theatre Siege. The Pharmacological Journal, Vol. 269, Nov. 16, 2002, 723-724.

[25] Schiermeier, Q.: Hostage deaths put gas weapons in spotlight. Nature 2002; 420: 7, Nov. 7 2002.

[26] WAX, Paul M., BECKER, Charles E. and Steven C. CURRY, MDs: Annals of Emergency Medicine, May 2003; Volume 41, Number 5, 700-705. See their Literature 19-24 & Stanley, T.: Human immobilisation. Europ. J. Anaesthesiol. 2003; 20: 427-428.

Table M-1: Characteristics of Opioids, Including Fentanyl Derivatives. (25)[27]****

	Relative Potency Compared to that of Morphine	Lipid Solubility*	Therapeutic Index**
Morphine	1	1,4	70
Meperidine	0.5	40	5
Methadone	4	120	12
Fentanyl	300	800	300
Sufentanil	4500	1800	25000
Alfentanil	75	150	1100
Remifentanil	220	18	33000
Carfentanil***	10000		10600

* Lipid solubility = octanol/water distribution coefficient.

** Therapeutic index = median lethal dose (LD50) / lowest median effective dose (ED50). WAX, Paul M., BECKER, Charles E. and Steven C. CURRY, MDs: Annals of Emergency Medicine, May 2003 Volume 41 Number 5, 700-705

*** Carfentanyl, known as Wildnil®, is the only opioid approved in the United States for animal use. A typical dose to immobilize seals is 10 µg/kg. It may be administered intravenously, but also with the same effect transmucosally or orally.[28]

**** The animal numbers from Table M-1 (1976) may not easily extrapolate to humans.

Sufentanyl is ten times more potent than fentanyl, is shorter acting even in high doses, and is available as a nasal spray. Its lipid solubility is much greater than fentanyl or morphine. In adequate doses it produces profound analgesia and narcosis. The stability of cardiac action under sufentanyl is impressive.

Carfentanyl is again 30 to 80 to 100 times as potent as fentanyl and has a therapeutic index 30 times higher, which means that narcotic activity will start at once with only a drop of the substance near a human, and that it is very well tolerated as long as the airways are kept open and adequate amounts of oxygen are in the breathing gas.

[27] Van Bever WF, Niemegeers CJ, Schellekens KH, et al. N-4-Substituted 1-(2-arylethyl)-4-piperidinyl-N-phenylpropanamides, a novel series of extremely potent analgesics with unusually high safety margin. Arzneimittel-Forschung. **1976**;26:1548-1551. in WAX, P. M., BECKER, C.E. and Curry, S.C. CURRY, MDs: Annals of Emergency Medicine, May 2003 Volume 41: 5, 700-705.

® = Registered Trademark.

[28] WAX, Paul M., BECKER, Charles E. and Steven C. CURRY, MDs: Annals of Emergency Medicine, May 2003 Volume 41 Number 5, 700-705.

Table M-2: Possible Substances Used in the Moscow Theatre

• Nitrous Oxide N_2O
• Ethylene ($H_2C{=}CH_2$)
• Acetylene
• Narcylen HC≡CH
• Cyclopropane (Trimethylen)
• CO
• Aliphatic Halogens
• "BZ", 3-Quinuclidinyl Benzylate,
• "Nerve Agents"
• Fentanyl
• Neuroleptics
• Dissoziative Anaesthetics
• Halothane
• Fentanyl Derivates

M.4 TECHNICAL MEANS FOR ADMINISTERING CHEMICAL NLW

The ideal effective NLW agent would be characterised by 4 properties:

Dynamic Parameters:

- Time of onset of effect: immediate.
- Duration of effect: sufficient for the specific operation.
- Recovery time: rapid.
- Reversibility: total.

Therapeutic Index (ratio of lethal dose to effective dose LD_{50}/ED_{50}): high.

Physical Parameters: easy to store, easy to handle, liquid or gas as required.

Sensory Quality: invisible, odourless, tasteless, neutral in temperature.

In the Moscow Theatre scenario, the incapacitant had to be injected into the large hall of the theatre via the ventilation system as a gas or an aerosolised liquid. This process had to be noiseless, invisible, and very fast, but without changing the preset ventilation flow rate. Under these circumstances it was a problem to build up the required level of concentration of the active agent in the hall. This could only be achieved by simultaneously flooding the ventilation system from many sources at different areas. In Moscow a group of experts evaluated the hostage crisis and offered a possible solution from scientific information available to the Ministry of Health. They applied available models and software for aerosol dispersion[29], which have been

[29] Baranov, V.N., V.V. Lazariev, V.V. Selivanov: System of special Means of Non-Lethal Effect to be applied by Police troops of Ministry of Internal Affairs, Russia, and Experience of their Application. Ministry of Internal Affairs, Moscow, RUSSIA, Bauman Moscow State Technical University, Moscow, RUSSIA. Ettlingen: 2. European Symposium 13.-14. May 2003, V13.

Minashkin, V.M.: Some Aspects of Application of the Aerosol "Non-Lethal" Weapon. Karpov Institute of Physical Chemistry, Moscow, RUSSIA. Ettlingen: 2. European Symposium 13.-14. May 2003, P48.

developed for calculation of fire fighting systems in compartments of engine rooms of naval vessels and industrial halls. The hall of the "North-East"-Theatre may be calculated as 50 x 100 x 12 Meters = 60.000 cubic meters. To fill the volume of the musical hall with an adequate concentration of the incapacitant per person, in a rough estimate, 19.5 kg of fentanyl were needed, for Sufentanil about 1.3 kg and for Carfentanil 0.65 kg[30]. The smaller the quantity required, the more difficult it would be to gain a homogenous spatial distribution in the musical hall.

Figure M-1 illustrates the effect of a non-lethal agent on human organisms according to the medical concept[31]. The curve on the left shows the dependence of the probability of the desired effect of a NLW on the human population depending on the strength of impact, in this case "dose". When the dose increases, undesired consequences, including fatalities, will appear, as shown by the curve on the right.

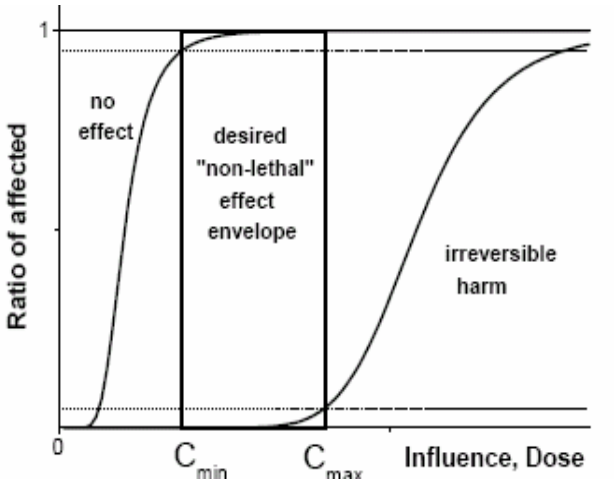

Figure M-1: Idealized Curves and Theoretical Useful "Envelope" for the Action of a Hypothetical NLW. The abscissa represents the ratio of affected persons out of the total population exposed, with "0" indicating that no person was affected and "100" indicating that all persons were affected. The ordinate indicates the relative "influence or dose" of the NLW used. Useful NLWs should occupy an operating envelope between having almost no effect, represented by the dose "Cmin" and with only a few persons with undesirable effects, represented by the dose "Cmax." (Also see Chapter 1.)

Typically the acceptable interval between desired and undesired effects, is that from 95 – 97% showing the desired effect to 3 – 5% showing an undesired effect, including damage or death. Minimal and maximal dose of this "desired operating envelope" often differ no more than 2 – 3 times.

At the first glance it looks simple to calculate the necessary dose and to apply the required amount of NL calmative somewhere in the middle of this envelope to guarantee success of operation, when terrorists are incapacitated and hostages are safely rescued.

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[30] Horizon: The Moscow Theatre Siege. BBC 2 (UK Television), Thursday January 15, 2004, 9 p.m., Transcript available http://www.bbc.co.uk/science/horizon/2004/moscowtheatretrans.html

[31] Klochikhin V.L.*, V.S.Pirumov**, A.V.Putilov*, V.V.Selivanov***: The Complex Forecast of Perspectives of NLW for European Application. *L.Ya.Karpov Institute of Physical Chemistry, 10, Vorontsovo pole, 103064 Moscow. **Russian Academy of Natural Sciences, 8, Warshavskoe shosse, 113105 Moscow. ***Bauman Moscow State Technical University, 5, Baumanskaya str., 105005 Moscow. 2nd European Symposium on NLW, May 13-14, 2003, Ettlingen, Germany, 16-15 & 16-16.

However the curve in Figure M-1 oversimplifies two facts of any comparable real situation. Firstly, this is an idealized curve for some average human. In reality, there is considerable variability is the dose-response of different human types (e.g., age and size) in different situations (e.g., degrees of stress, hunger, sleep). Furthermore the table assumes some instantaneous and specific dose, but in reality it is the dose-rate and accumulated dose that matter for the effect, and, this "time of exposure" can vary greatly, as well, from 10 min necessary for fighting operation in a big defended building to 30 min necessary to fulfil hostage evacuation from the affected area and for first medical aid.

In the Moscow Theatre situation, it took perhaps 40 – 60 minutes to fill the theatre hall with an effective concentration of gas, subdue the terrorists, and begin to evacuate the hostages. In this case the "desired operating envelope" simply disappeared. If the level of 95 % efficiency is absolutely required to neutralize terrorists and to prevent total mass destruction, there is no chance of eliminating some severe consequences and fatalities.[32]

M.5 ADDITIONAL DISCUSSION OF MOSCOW THEATRE INCIDENT

Four days after the event, the Russian Health Minister stated that the gas "cannot by itself be called lethal".[33] Despite this claim, 129 (16%) of the 800 hostages in the theatre died, and more than 650 of the survivors required hospitalisation. The Russian Health Minister attributed the deaths of the hostages to their poor condition from limited food and water and immobility during 3 days of captivity. By 12 days after the rescue, 67 hostages and 9 rescuers still remained hospitalised, 5 in critical condition.

From this statement we may conclude that the high numbers of dead and additional hostages with severe hypoxic defects and other injuries in consequence had not been expected. Some possible reasons for the deviation from theory might bee offered:

- The concentration of the incapacitant had to be very high to be effective in the large hall.
- Several sources were needed to blow the aerosol into the hall, so hostages were exposed to different concentrations at different places.
- The different weight of the aerosol compounds towards air might have provoked different concentrations of different substances at different places.
- Large volumes of the aerosol might have pushed away the air. Low oxygen concentration might have resulted in asphyxia.
- The hostages differed with respect to age, sex, weight, body-mass index, state of general health, fatigue, dehydration, and panic or fatalism, which influences the respiratory rate.
- The early German analytic data showed evidence of halothane, plus the Russian admission to using a fentanyl derivative suggests that more than one agent was used. This may also explain the failure to fully obtain reversal with naloxone in some cases, although hypoxic brain injury also may have contributed.

[32] Ibidem.

[33] Quoted from Wax: 8. Brown D, Baker P. Moscow gas likely a potent narcotic: drug normally used to subdue big game. Washington Post. November 9, 2002: A12. in WAX, Paul M., BECKER, Charles E. and Steven C. CURRY, MDs: Annals of Emergency Medicine, May 2003 Volume 41 Number 5, 700-705.

The most probable cause of death is that the hostages fainted in their seats to profound unconsciousness. In consequence, their airways were blocked and hypoxia developed with irreversible brain damage after about 6 minutes. From blowing aerosol into the hall to the beginning of the liberation action, 60 minutes elapsed. Even if the anaesthetic activity had been very short, the effects of hypoxia are sufficient to cause death.

The need to find and neutralize the widely spread ordnance may have been why there was a delay in starting the rescue, however there were no preparations for rescue! There were no rescuers organized, no first aid personnel, no physicians, and no ambulances. Ironically, opioid intoxication is a relatively simple poisoning to treat. Preparation of rescuers and medical teams with suitable stores of effective antidotes, such as naloxone, is essential. Antidotes to overcome an opiate poisoning were not sufficient, only a small number of syringes, no resuscitators, and only a few litters were seen[34]. Even from the official side, there were claims that not enough physicians were available to administer the antidotes.[35] In fact any helper could have injected naloxone into the muscles. There was no medical assistance seen being given to the hostages, no infusions, and no artificial ventilation. It is expected that several of the surviving hostages, who were delivered to the hospitals, will suffer from hypoxic lesions and brain damage.

M.6 CONCLUSIONS FROM THE MOSCOW THEATRE INCIDENT

More than 800 people were taken hostage in a Moscow theatre in October 2002 by armed Chechen rebels and were about to be killed. Given the large number of explosives in the hands of the hostage takers, a conventional assault or the use of more toxic chemical agents would probably have significantly increased the number of casualties in a destroyed theatre.

In an attempt to subdue the rebels and to rescue the hostages, the Russian authorities inserted an "incapacitant". The intent was likely to win control of the theatre with as little loss of life as possible. **This was achieved!** Although it may seem excessive that 16% of the 800 hostages died from the "gas" exposure, still **84% survived**. We do not know that a different tactic would have provided a better outcome. The use of a "sleeping gas" or "calmative" or "incapacitant" agent in this setting is a novel courageous attempt at saving the most lives. This counterterrorist action showed on the other hand that chemical "non-lethal" weapons are not always non-lethal. The variability of the situation (e.g., where one was located within the theatre) combined with the variable sensitivity of the population of individuals in the theatre (e.g., age, body size), combined with the disastrous consequences of failure, created a situation where non-lethality could not be guaranteed.

The planning and execution of medical attention to the hostages seems to have been scanty. The tragic outcome due to poor preparation of the rescue activities and therapeutic strategy shows how important tactical medical planning is in an overall operative environment[36].

M.7 SUPPLEMENT

The Moscow Dubrovka Theatre was reopened in February 2003[37]. More than 1000 auditors, amongst them several of the survivors, joined the first night of the "North-East Musical".

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[34] Van Damme, B.: Moscow Theatre Siege. The Pharmacological Journal, Vol. 269, Nov. 16, 2002, 723-724.

[35] arte, 30.09.03, 20:45 – 21:35.

[36] Hilflose Retter: Der Spiegel 45, S. 128 vom 04.11.2002.

No information is yet available about the outcome of the hundreds of patients treated in 8 hospitals all over the Moscow area. To seriously calculate the values and risks of the use of "non-lethal" agents it should be published some time.

After Moscow, we have to rethink the medical implications of all non-lethal agents, given the impossibility of getting an appropriate dose to all individuals in a large crowd[38].

Ongoing international scientific research is focussed on achieving broader therapeutic indexes and increased drug safety. Combinations of specific drugs, with different times of onset, different times to maximum effect, and with specific antagonists administered at the same time are under evaluation.

[37] KN 10.02.2003.

[38] Jan van Aken, toxicologist, head of the Hamburg-based office of the Sunshine Project.