LITHUANIAN UNIVERSITY OF HEALTH SCIENCES

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Group 31

Outcome of Hypothermia in the Intensive Care Unit

Supervisor: Prof. Vidas Pilvinis, MD, PhD

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DĖL PRITARIMO TYRIMUI

LSMU Bioetikos centras, įvertinęs (MA) vientisų studijų programos – MEDICINA
VI k. stud. Tarek Salmon (mokslinio darbo vadovas: prof. Vidas Pilvinis, LSMUL KK
Intensyviosios terapijos klinika) mokslinio-tiriamojo darbo temos: „CAUSES, DIAGNOSIS
AND TREATMENT OF HYPOTHERMIA“ tiriamojo darbo anotaciją, kuri leidžia spręsti, jog
planuojamame tyrome neturetų būti pažeistos tiriamojo teisės, todėl šiam tyrimui pritariamo.

Bioetikos centro vadovo pavaduotojas

[Signature]

doc. E. Pečiūnas
Summary:

This study is done by Tarek Salman in the Department of the Intensive Care Unit about the “outcome of hypothermia in the intensive care unit”. It’s a retrospective study, the aim is to identify the incidence of hypothermia in the intensive care unit, as well as to identify the major causes and outcomes of hypothermia and to analyze the important diagnostic tests in hypothermia. The objective of the study, is to divide hypothermia according to its severity based on the temperature into mild, moderate and severe and compare the diagnostic tests results and outcomes therefore to estimate the association between the severity of hypothermia and its outcome. The data was collected from the patient records for those who were admitted to the intensive care unit at KaunoKlinikos University Hospital between the periods 12-2014/12-2015. Subjects were identified by means of the international classification of diseases version 10 (ICD10) using the code T68.10 patients were identified as hypothermic during this period, and the diagnosis was based by measuring the core body temperature, patient neurological status and by evaluating the clinical symptoms and signs. Descriptive statistics of the laboratory data, diagnostic examination, presence of complications and the cause of hypothermia was done and include the mean values, standard deviation, median and the percentage, also a comparison between the types of hypothermia was done. We found that the incidence of hypothermia in KaunoKlinikos intensive care department is approximately 3.3/100000 cases per year. The major causes of hypothermia were due to cold air exposure with the presence of alcohol intoxication and trauma as a concomitant factors. The presence of complications were high among the patients and the most common complication was pneumonia among most of the patients without a correlation with the severity of hypothermia. The major informative methods to diagnose hypothermia is by measuring the core body temperature and by the presence of Osborn wave on ECG. All the patients had metabolic acidosis and lactate was higher in severe hypothermia than moderate hypothermia. 80% of the patients were unconscious in the admission to the department.

Acknowledgment:

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Conflict of interest:

The author declares no conflicts of interest.

Practical recommendations.
**Introduction:**

Accidental hypothermia is defined as a central core temperature less than 35 degree. It’s classified based on its severity into mild (32-35degree), moderate (28-32degree) and severe (<28degree) [1]. Several conditions predispose to hypothermia including age, malnutrition, dementia, hypothyroidism, hypopituitarism, septicemia, alcohol consumption with acute and chronic intoxication, neuroleptic drugs and drowning and immersion [2]. Diagnosis of hypothermia starts by measuring the central core temperature, evaluation of the patient status, blood gas levels and Ph, systolic blood pressure, the presence of Osborn wave on ECG and the elevation of lactate in the body. The treatment is divided into two methods passive external and active internal according to the severity of hypothermia. Passive methods is used in case of mild hypothermia and it increases the temperature of the body by 0.5-1degree/hour, whereas active rewarming methods is used in case of moderate and severe hypothermia, it includes warm intravenous, body cavity lavage and extracorporeal methods. In the hospital the treatment starts with the minimally invasive rewarming techniques, in case hypothermia is not responding to medical management therefore extracorporeal techniques as cardiopulmonary bypass are considered [3,14]. Hypothermia can cause multisystemic complications as cardiovascular, respiritory, neurological, renal and coagulopathy [1-3,21]. Hypothermia was the primary cause of death in Poland between the period 2009-2012 in 1836 residents [7].

Diagnosis of hypothermia is high in the cold countries such as Lithuania and there wasn’t any previous study about the incidence of hypothermia in the intensive care unit therefore we decided to make a retrospective cohort study by collecting the data from the hypothermic patient records, and it was indicated to obtain a conclusion about the major causes of hypothermia, important diagnostic tests and the major complications according to the severity of hypothermia between the patients admitted to the intensive care unit at KaunoKlinikos University Hospital. This retrospective study includes 10 patients, were admitted between the periods 12-2014/12-2015.

**Aim and objective:**

Lithuania is considered a cold country in the Baltic region, therefore the incidence of hypothermia is considered as a life threatening condition in this country. The aim of this retrospective study is to identify the incidence of hypothermia in the intensive care unit, as well as to indentify the major causes and outcomes of hypothermia and to analyze the important diagnostic tests in hypothermia.
The objective of the study, is to divide hypothermia according to its severity based on the temperature into mild, moderate and severe and compare the diagnostic tests results and outcomes therefore to estimate the association between the severity of hypothermia and its outcome. We collected the records of 10 patients who were admitted to the intensive care department between the periods 12-2014/12-2015.

**Literature review:**

In this literature review, 30 articles were being reviewed with a total of 2746 patients between 2006 and 2015. I have divided this review into causes, diagnosis, prevention, treatment and outcome of hypothermia, some articles were used in all these subjects whereas some articles are specific for each subject.

Normal body temperature in the human is between 36.4 degrees and 37.5 degrees. Body temperature is maintained by a balance between heat loss and heat production, therefore any condition that disturb this balance will cause a decrease or an increase of the body temperature [1,3]. Hypothermia is a rare and unusual condition which is considered as a life threatening condition and characterized by a core body temperature less than 35 degree [1-9]. Clinically hypothermia was recognized in the middle of the 20’s century, because the clinical tool to measure the temperature was started in the early of 1900’s[4].

Extremely cold stress is the leading factor for hypothermia[1,3] and its incidence increases mostly in winter. According to “Les Gordon team doctor 2014”[5], in the British mountain only 5 cases of severe hypothermia occurs each year. On the other hand, “Brandstrom et al.”[6]described that the incidence of hypothermia is increasing in the subarctic region from 1.1/100000 cases to 3.4/100000 per year. In another study, “Korinski et al. 2015” [7] showed that the prevelance of hypothermia have been 5.05/100000 per year in Poland. “ P.Petrona et al. 2014” [1] had classified hypothermia according to body temperature, into mild (32.35 degrees), moderate (28-32 degrees) and severe (less than 28 degrees). On the other hand “Douglas, Brugger 2012”[3], had staged hypothermia according to vital signs with the Swiss staging system in case body core temperature cannot be measure, in addition “les Gordon team doctor 2014” [5] had described also the Swiss staging system. “Epstein, Anna 2006” [2] had mentioned the conditions predisposed to hypothermia which are old age, malnutrition, dementia, hypothyroidism, septicemia, alcohol intoxication and neuroleptic drugs. “Brandstorm ,Johanson 2014” [6] stated that the major associated factor of hypothermia in northern Sweden are alcohol consumption, dementia and psychiatric diagnosis. “Korinski et al 2015” [7] analyzed the major causes of hypothermia in Poland in 42
emergency and they were alcohol intoxication in cold air exposure with 68%, cold air exposure 19% and water immersion 6%. “Wilson et al. 2007” [10] reported about a case history of an 80 year old man who presented with hypothermia to Edinburg emergency hospital about 1 hour of ingestion of 750ml of vodka. In a new study in Turkey “Aygum, Vuram et al. 2015” [9] showed that hypothermia can be linked to mad honey poisoning in 3 patients because grayanotoxin can depress the hypothalamus.

**Diagnosis**

“Epstein and Anna 2006” [2] stated that symptoms and signs classifies the severity and the diagnosis of hypothermia and specific laboratory tests are used to diagnose hypothermia including, electrolytes, complete blood count, glucose, coagulation, ECG, arterial blood gases and thyroid function test. On the other hand in another different studies [3,4,6,7,8,11,12,16,17,19] showed that the diagnosis of hypothermia starts with the measurement of the core body temperature in order to make the correct management, therefore there are several parameters to measure correctly the body temperature, according to ERC guidelines of 2010 they advised to take the temperature from esophagus, rectal, urinary bladder or from the tympanic membrane [20]. On the other hand, in the study of “Brandstorm et al 2014”[6] showed that measuring the temperature from the esophagus is the most accurate because it measures the temperature of the internal organs and from the tympanic is the less accurate. “Strapazzon et al. 2014” [17] made a systemic review about the importance of the best location to measure the temperature and it was also esophageal location is the most accurate. Another diagnostic test of hypothermia was done by “Senturk et al.2011”[13] in Turkey which shows J deflection on ECG in 80% of hypothermic patients. According to a new research done by “Szeremeta et al.2015” [18] in Poland described that in hypothermic patients coagulation decreases due to alteration of platelets function, therefore the patient will show thrombocytopenia.

**Prevention and treatment**

“Epstein and Anna 2006” [2] described how the treatment should start by intubation, assessment of fluid status and giving warm IV fluids. Other important management in case of thiamine deficiency, need to give IV thiamine, in case of sepsis give broad spectrum antibiotics. They also describes rewarming strategies as passive rewarming in case of mild hypothermia and active rewarming in case of moderate and severe hypothermia. In a study in Australia about nursing and medical staff knowledge regarding monitoring and management of hypothermia “Sharyn et al. 2006” [11] showed that medical staff were unsure about the strategical treatment and they concluded that prevention should be required in
the pre-hospital setting with a protocol including removing of wet clothing, use of blankets, warm fluids. In addition in 2010 a study was done in the US military in Afghanistan by “Hall et al.2010” [12] which showed a dramatically decrease from 6300 cases of hypothermia during Korean war to 19 cases during 7 years, the reason was concluded due to the importance of education about the cold weather and improved equipments such as leather boots and sleeping bags with wool. In 2011 “Avellanas et al.” [14] made a systemic review about the management of hypothermia and described its treatment according to the grade of classification of hypothermia. They also showed the importance of extracorporeal rewarming under cardiac arrest which assure complete neurological outcome, in addition another study in 2012 “Brown et al.” [3] described how the prognosis of patients with cardiac arrest have improved with the use of extracorporeal techniques. “Karlsen et al. 2013” [8] did a survey of Norwegian pre-hospital about the equipment used to prevent and treat hypothermia which are cotton blankets, plastic bubble wrap because active heating services are absent in the ambulance units. In northern Sweden hospitals “branstorm 2014” [6] stated that active rewarming with forced air warming system is the most commonly used. In a new article in Poland “Korinski 2015” [7] the most common treatment in 42 ER was IV fluid and forced air warm with carbon fiber blanket and they showed that non-invasive treatment is effective and safe without the use of extracorporeal treatment.

**Outcome**

Many studies were done about the outcome of hypothermia, in this part 11 articles were reviewed with a total of 1725 patients. “Alty and Ford 2008” [21] described the outcome of a 61 year old woman who had 6 occasions of severe hypothermia over 2 years and the major outcomes were increasing of plasma viscosity, thrombocytopenia, bone marrow depression and acute pancreatitis in addition “Petrona et al.” [2] described multisystemic complications after hypothermia on the level of cardiovascular system, respiratory system central nervous system, coagulation system and renal system. “Alexander et al 2010” [23] in their study, had 105 patients treated for cardiac arrest after spontaneous hypothermia and they demonstrated that 69% had unfavorable neurological outcomes on the other hand “Brown, Brugger 2012” [12] showed in their study that the absence of hypoxic events in hypothermic patients with cardiac arrest can survive without neurological impairment. “Ploeg et al 2010” [24] did a retrospective study between 2000-2008 about the complications and outcomes of hypothermia with 84 patients admitted to the ER of VU university medical center in Amsterdam and found that complications 79 patients and death 68 patients were high after complete rewarming and mostly the complications were pulmonary, cardiac, renal
and neurological. “Ghoussein and Hegazi 2011” [25] did a case report about a 41 year old male presented to the hospital in Kuwait with a temperature of 29.5 degrees and depressed level of consciousness, after doing an XRAY they found bilateral bronchopneumonia and the blood culture showed brucellamitensis therefore they stated that brucellosis should be considered in the differential diagnosis in septicemic patient with hypothermia. “Laupland et al.2012” [26] had a study on 981 patients presented to the French ICU’s between April 2000 and November 2010, among these 981, 648 had mild hypothermia, 288 moderate and 45 had severe hypothermia, they concluded the presence of severe hypothermia is a risk factor for the development of ICU acquired infection with 13.3% blood infection and 24.5% pneumonia comparing to mild hypothermia with 7.6% blood infection and 11% pneumonia and moderate hypothermia with 6.9% blood infection and 9.4% pneumonia. In another study “Fugate et al.2013” [27] which included 133 patients between 2006-2011 who had cardiac arrest after hypothermia they made a 21 months follow up and 77 patients stayed alive and nearly 80% were able to go back to normally to their work. In addition “Shober at al.2014” [29] did a 20 year review about cardiac arrest due to hypothermia and they concluded that the prognosis was excellent in patients who had cardiac arrest with hypothermia due to alcohol intoxication. In a new study about the effect of hypothermia on the heart after ECMO rewarming “Darocha et al.2015” [30] in 9 patients who presented with severe hypothermia in Poland, therefore echocardiography was done on admission and showed moderate-severe bi-ventricular systolic dysfunction and moderate bi-ventricular diastolic dysfunction plus cardiac biomarkers which showed myocardial damage. On discharge echocardiography showed mild-moderate left ventricular diastolic dysfunction in 6 patients and normal left ventricular systolic dysfunction in 5 patients, therefore they concluded that after severe hypothermia treated with ECMO Bi-ventricular diastolic dysfunction persists despite normal systolic function.

**Conclusion**

As a conclusion of this review about the causes, diagnosis, treatment and outcome of hypothermia, I can say that hypothermia is when the body temperature is less than 35 degrees, it can be divided into mild (32-35 degrees), moderate(32-28 degrees) and severe(less than 28 degrees). The major cause of hypothermia is cold exposure with the presence of cofactors such as alcohol intoxication, dementia and psychiatric factors. Hypothermia is diagnosed firstly by measuring the body core temperature through esophagus which is the most accurate and by specific laboratory tests such as complete blood count, platelets, electrolytes and by the presence of J wave on ECG. The treatment of hypothermia should be started in the pre-hospital by removing wet clothe, use of blanket and warm fluids,
in the hospital the patient must be intubated, warm IV fluid must be put and forced air warm, in case of severe hypothermia with cardiac arrest extracorporeal management is effective. Major outcomes and complications of hypothermia can be multisystem organs of the body with thrombocytopenia, respiratory acidosis and cardiac arrest and the major outcome of severe hypothermia is pneumonia.

**Methods and materials:**

This retrospective study was conducted with the approval from the ethical review board at LSMU. The research was carried on December 2015, the data was collected from the patient records for those who were admitted to the intensive care unit at KaunoKlinikos University Hospital between the periods 12-2014/12-2015. Patient codes were taken from the intensive care database and the case records were taken from the archives of the hospital. Subjects were identified by means of the international classification of diseases version 10 (ICD10) using the code T68. 10 patients were identified as hypothermic during this period, and the diagnosis was based by measuring the core body temperature, patient neurological status and by evaluating the clinical symptoms and signs. Patient records were reviewed by the head of the intensive care unit and the data required for collection were organized according to the head of the department. Data was categorized according to the severity of hypothermia into mild, moderate and severe. Mild hypothermia is considered when the temperature is between 34.9-32 degree, moderate hypothermia is when the temperature is between 31.9-28 degree and severe hypothermia is when the temperature is less than 28 degree. Data were categorized according to the cause of hypothermia into two categories, the 1st category is the exposure to cold air and the 2nd is the exposure to cold water such as during rain or immersion, in addition three cofactors were divided among the categories and the cofactors are alcohol intoxication, trauma and homelessness. During hospital admission, the data consist of the core body temperature which was measured considering that the temperature was measured from the esophagus and from the rectum, evaluation of the neurological status, measuring the systolic blood pressure, presence of Osborn wave on ECG, partial pressure of oxygen and carbon dioxide, Ph and lactate level in the blood. We assumed that the rewarming methods was passive and active internal with warm intravenous. The presence of complications were also registered during the hospital stay and an estimation of association between the severity of hypothermia and the presence of complications was studied.
Descriptive statistics of the laboratory data, diagnostic examination, presence of complications and the cause of hypothermia was done and include the mean values, standard deviation, median and the percentage, also a comparison between the types of hypothermia was done. They were analyzed using SPSS 16.0. The comparison between the severity of hypothermia was done only by using these descriptive values and by the graphs.

**Results:**

During this retrospective study, 10 patients were identified as hypothermic patients in the intensive care unit according to the international classification ICD10 as T68. Seven of these patients were male and three patients were female admitted between the periods 12-2014/12-2015. These patients were classified according to the severity of hypothermia into mild, moderate and severe. Five patients had moderate hypothermia and 5 patients had severe hypothermia and there wasn’t any patient with mild hypothermia. The causes of hypothermia are listed in table 1, it’s divided into 2 categories representing the cause of hypothermia, the 1st one is cold air exposure and the 2nd is cold water exposure, plus the combination of concomitant factors which are alcohol intoxication and trauma. We found that exposed to cold air were 7 , 3 out of 7 patients the concomitant factor was alcohol intoxication and 4 out of 7 patients, trauma was the concomitant factor. Patients who had hypothermia caused by cold water (rain or immersion) were 3, 2 patients out of 3 the concomitant factor was alcohol intoxication and 1 patient had a trauma. Table 2 describes the characteristics of the patients admitted to the intensive care upon their arrivals. The average of the age was 57.2±8.7, the lowest temperature which was registered was 23 degree and the highest was 31 degree so the severity of hypothermia was ranged between moderate and severe, therefore 5 patients had moderate hypothermia and 5 patients had severe hypothermia. On admission , 70% of the patients were found unconscious whereas only 30% were conscious. The mean of the systolic blood pressure was 105±31mmhg, 70% of the patients (n=7) had a systolic blood pressure lower than the mean and considered hypotensive. The average Ph on admission was 7.14±0.18 which is considered acidic therefore 10 patients had acidic Ph and the low level of Ph was 6.8 and the highest one was 7.31. The mean of PaO\(_2\) was 115.19±35mmhg which is normal because it was considered that the patient had oxygen resuscitation in the ambulance and only one patient had hypoxemia with a level of 51mmhg. The mean of PaCO\(_2\) was 36.63±15.81 which is considered in its lower limit because the normal level of PaCO\(_2\) is 36-45mmhg, 40%(n=4) of the patients had PaCO\(_2\) lower than the mean, 30%(n=3) of the patients had
PaCO₂ within the normal range and 30% (n=3) of the patients had PaCO₂ higher than the normal range. The PaO₂ and the PaCO₂ is not accurate because it was considered that the patients had an oxygen mask in the ambulance before their admission to the intensive care unit. 80% (n=8) of the patients had a positive Osborn wave on their ECG and only 20% (n=2) of the patients didn’t have any changes on their ECG. The complications which were seen are listed in table 3, with 50% of the patients (n=5) had only pneumonia, 20% of the patients (n=2) had a complex complication with pneumonia, 20% of the patients (n=2) didn’t have any complication and 10% (n=1) had only pyelonephritis. The correlation between the temperature and the complications is listed in table 4, in this table we cannot conclude any specific correlation between the severity of the temperature and the presence of a specific complication. By evaluating the temperature of the patients, we can divide the patients according to the severity of the temperature into moderate hypothermia (n=5) and severe hypothermia (n=5) with the absence of any patient with mild hypothermia, and in moderate hypothermia it was included only males whereas in severe they were 3 females and 2 males. We compared the results of the diagnostic tests plus the results of the laboratory values between the patients in moderate and severe hypothermia. The comparison included systolic blood pressure, Ph, PaO₂, PaCO₂, platelets level and lactate levels. In figure 1 the systolic blood pressure of the 2 groups is listed, we can conclude that the blood pressure in severe hypothermia is higher than moderate hypothermia with a mean 125±27.83 mmHg in severe compared to 85.2±15.89 in moderate hypothermia. Figure 2 shows the Ph values of the 2 groups was compared, in severe hypothermia 7.16±0.213 is higher than moderate hypothermia 7.12±0.17, in both groups the Ph is acidic. PaO₂ and PaCO₂ were also compared in both groups but we assumed that the patients received oxygen therapy in the ambulance so they are not so accurate to check the difference and to check the real values in case of hypothermia. Figure 3 shows the platelets levels, the mean in moderate hypothermia was 156 and 2 patients had thrombocytopenia whereas in severe hypothermia it was higher with 168 and 2 patients had thrombocytopenia. Figure 4 shows the lactate levels in blood in both groups, in severe hypothermia the lactate level was much more higher than moderate hypothermia with a mean 5.62±1.27 compared to 2.3±0.65. In severe hypothermia 100% of the patients (n=5) had an Osborn on their ECG whereas 60% of the patients (n=3) had Osborn wave in moderate hypothermia. By checking the table 4 which describes the temperature and the complications of the patients, it shows that in severe hypothermia 3 patients had pneumonia, 1 patient had pyelonephritis and 1 patient didn’t have any complication. On the other hand, in moderate hypothermia 2 patients had pneumonia, 1 patient had pneumonia plus pancreatitis plus acute renal failure, 1 patient had MI plus left fascicular block plus pneumonia and 1 patient without any complication, therefore there was no significant
difference between the 2 groups and pneumonia was the common complication. We assumed that all the patients were mostly warmed by IV fluids.

**Discussion:**

This retrospective cohort study includes 10 patients who were admitted to the intensive care unit in LSMUKK because of hypothermia, between the periods 12-2014/12-2015. With a frequency of 0.8 patients per month, 3 patients were females and 7 patients were males.

Hypothermia is a life threatening condition, it’s considered when the body temperature is less than 35 degree [1-9]. It’s classified into mild (32-35 degree), moderate(32-28degree) and severe(<28degree) [1]. In our study 50% of the patients (n=5) had moderate hypothermia with a mean temperature of 29.4±1.38 and 50% had severe hypothermia with a mean temperature of 25.24±1.42 and the average age of all the patients was 57.2±8.79. The incidence of hypothermia was about 3.33/100000 cases per year in Kaunas which is about the same number of cases in the subartic region in northern Sweden [6], on the other hand in Poland the incidence of hypothermia is about 5.05/100000 cases per year, therefore in our study we don’t have any statistical data about hypothermia in other cities in Lithuania. We divided the patients according to the severity of hypothermia by measuring the core temperature, on the other hand, hypothermia can be classified according to the Swiss staging which is based on vital signs and symptoms in case the core body temperature cannot be measured [3,5]. In our study, 70% (n=7) of the causes of hypothermia were due to cold air exposure with 30% had an intoxication and 40% of the patients had trauma. On the other hand, 30% of the causes were due to cold water exposure and 20% of the patients had intoxication and 10% had trauma. The major causes of hypothermia in northern Sweden were due to alcohol consumption, dementia and psychiatric diagnosis [6]. In Poland, 42 ER were analyzed and they found that 68% of the hypothermia were due to alcohol intoxication in cold air exposure, 19% due to only cold air exposure and 6% due to water immersion[10]. In Turkey, a recent 3 cases reports were done and they linked hypothermia to mad honey poisoning due to the presence of grayanotoxin [9]. The diagnosis of hypothermia was based on measuring the core body temperature, in addition to the presence of Osborn wave on ECG and other laboratory tests such Ph, PaO₂, PaCO₂, platelets level and lactate level in the blood. 80% of all the patients had an Osborn wave on their ECG which is similar to a study done in Turkey and showed that 80% of severe hypothermic patients had j deflections on ECG [13], in our study 100% of the severe hypothermic patients had j deflection and 60%
of the moderate hypothermic patients had j deflection. The diagnosis of hypothermia starts with the measurement of the core body temperature as it’s stated in these studies[3,4,6,7,8,11,12,16,17,19], whereas another study stated that laboratory tests are used for the diagnosis of hypothermia [2]. In our study we assumed that the temperature was measured from the esophagus and from the rectum according to ERC guidelines [20], because it was proved that the temperature from the esophagus is more accurate since it reflects the temperature of the internal organs [6,17]. We assumed that the treatment of hypothermic patients in ICU was only by warm IV fluid plus supportive treatments and no extracorporeal rewarming methods were used. In another side, a systemic review described that the management of hypothermia must be accomplished according to its grade of severity, and that extracorporeal management under cardiac arrest prevents the neurological outcomes, in Northern Sweden active rewarming with forced air warming system is the most commonly used [6]. The complications in our study were high with 80% and only 20% of the patients didn’t have any complication. 5 patients had only pneumonia, 1 patient had pneumonia plus pancreatitis plus acute renal failure, 1 patient pneumonia plus MI plus left fascicular block, 1 patient had pyelonephritis and 2 patients without any complications, as a conclusion pneumonia is a very common complication among the most hypothermic patient in the intensive.3 patients with severe hypothermia had only pneumonia whereas in moderate hypothermia, pneumonia was one of the complications presented in 4 patients therefore we can conclude that pneumonia was presented as a main complication despite the severity of hypothermia. 40% of the moderate hypothermic patients had thrombocytopenia and 40% of the severe hypothermic patients therefore both groups had the same percentage of thrombocytopenia. In one case report, it showed that hypothermia causes bone marrow depression, anemia and thrombocytopenia [21]. Multisystemic complications were also described which include cardiovascular, respiratory and central nervous system complications in addition to coagulopathy [2]. In 2012, a study in the French ICU concluded that the presence of hypothermia is a risk factor for infection. Our study showed that hypothermic patients had metabolic acidosis since the mean Ph was 7.14±0.183 and the average of lactate 3.96±1.99. In severe hypothermia the lactate level was higher than moderate hypothermia, the mean was 5.62±1.277, comparing to 2.3±0.65.

Our study, has several limitations, one of them is that we had interpreted hypothermic patients who were admitted to the intensive care unit only, because some of the hypothermic cases could have been admitted to the emergency department therefore we don’t have the correct data about the cases of the hypothermia admitted to the hospital per year. In addition, there’s no data about hypothermia in different cities therefore we cannot compare the number of hypothermic cases in Lithuania to the European countries, so this study can be a base for the future studies about hypothermia in Kaunas or in Lithuania.
Another limitation, is with the values of PaO2 and PaCO₂, because we assumed that the patients had oxygen therapy in the ambulance before arriving to the intensive care unit therefore these values in the study cannot be based as a real values in case of hypothermia.

**Conclusion:**

This study describes the incidence, causes and the complications of hypothermia in the intensive care unit in LSMU KK. We found that the incidence of hypothermia is high in the intensive care unit, the major cause of hypothermia was due to cold air exposure with the presence of alcohol intoxication and trauma as a concomitant factors. The presence of complications were high among the patients and the most common complication was pneumonia among most of the patients without a correlation with the severity of hypothermia. The major informative methods to diagnose hypothermia is by measuring the core body temperature and by the presence of Osborn wave on ECG. All the patients developed metabolic acidosis and lactate was higher in severe hypothermia than moderate hypothermia. The actual incidence of hypothermia in LSMU KK can be higher than the official data because many accidental hypothermia could be admitted to the emergency department. Evidence based treatment of accidental hypothermia does not exist so almost the same treatment was applied for all patients.
Table 1  Causes of hypothermia and concomitant factors.

<table>
<thead>
<tr>
<th>Causes</th>
<th>Number</th>
<th>concomitant factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Intoxication</td>
</tr>
<tr>
<td>Cold air exposure</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Cold water exposure</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2  Characteristics of patients upon admission to ICU.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, year</td>
<td>57.2±8.79</td>
</tr>
<tr>
<td>Temperature</td>
<td>27.4±2.72</td>
</tr>
<tr>
<td>Systolic Bp</td>
<td>105.3±30.1</td>
</tr>
<tr>
<td>Ph</td>
<td>7.14±0.18</td>
</tr>
<tr>
<td>PaO₂</td>
<td>115±35.8</td>
</tr>
<tr>
<td>PaCO₂</td>
<td>36.63±15.81</td>
</tr>
<tr>
<td>Platelets</td>
<td>162.2±89.96</td>
</tr>
<tr>
<td>Lactate</td>
<td>3.96±1.99</td>
</tr>
</tbody>
</table>

*Data are presented as mean±standard deviation.*

Table 3  Frequency of complications.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>5</td>
</tr>
<tr>
<td>Pancreatitis, Pneumonia,acute renal failure</td>
<td>1</td>
</tr>
<tr>
<td>Myocardial infarction, Pneumonia</td>
<td>1</td>
</tr>
<tr>
<td>Pyelonephritis</td>
<td>1</td>
</tr>
<tr>
<td>No complications</td>
<td>2</td>
</tr>
</tbody>
</table>
**Table 4** Correlation between the temperature and the complications

<table>
<thead>
<tr>
<th>Patients</th>
<th>Temperature</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26.8</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>Pyelonephritis</td>
</tr>
<tr>
<td>3</td>
<td>30.8</td>
<td>No complication</td>
</tr>
<tr>
<td>4</td>
<td>25.4</td>
<td>No complication</td>
</tr>
<tr>
<td>5</td>
<td>29</td>
<td>Pancreatitis, pneumonia, acute renal failure.</td>
</tr>
<tr>
<td>6</td>
<td>23</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>7</td>
<td>28</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>8</td>
<td>31</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>9</td>
<td>28.4</td>
<td>Mi, Pneumonia, left fascicular block</td>
</tr>
<tr>
<td>10</td>
<td>26</td>
<td>Pneumonia</td>
</tr>
</tbody>
</table>

**Figure 1.** Systolic blood pressure measurement of moderate and severe hypothermia.
Figure 2. Ph values of moderate and severe hypothermia.

Figure 3. Platelets level of moderate and severe hypothermia.
Figure 4. Lactate levels of moderate and severe hypothermia.
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