Diabetes Mellitus

Diabetes Mellitus

- Chronic metabolic disease
- One of the most common diseases in North America
  - Affects 5% of USA population (12 million people)
- Results in
  - ↓ insulin secretion by the Beta (β) cells of the islets of Langerhans in the pancreas, AND/OR
  - Defects in insulin receptors on cell membranes leading to cellular resistance to insulin
- Leads to an ↑ risk for significant cardiovascular, renal and ophthalmic disease

Regulation of Glucose

- Dietary Intake
  - Components of food:
    - Carbohydrates
    - Fats
    - Proteins
    - Vitamins
    - Minerals

Regulation of Glucose

- The other 3 major food sources for glucose are
  - carbohydrates
  - proteins
  - fats
- Most sugars in the human diet are complex and must be broken down into simple sugars: glucose, galactose and fructose - before use

Regulation of Glucose

- Carbohydrates
  - Found in sugary, starchy foods
  - Ready source of near-instant energy
  - If not “burned” immediately by body, stored in liver and skeletal muscle as glycogen (short-term energy) or as fat (long-term energy needs)
  - After normal meal, approximately 60% of the glucose is stored in liver as glycogen

Regulation of Glucose

- Fats
  - Broken down into fatty acids and glycerol by enzymes
  - Excess fat stored in liver or in fat cells (under the skin)

Regulation of Glucose

- Pancreatic hormones are required to regulate blood glucose level
  - *glucagon* released by Alpha (α) cells
  - *insulin* released by Beta Cells (β)
  - *somatostatin* released by Delta Cells (∂)

Regulation of Glucose

- Alpha (α) cells release *glucagon* to control blood glucose level
  - When blood glucose levels fall, α cells $\uparrow$ the amount of glucagon in the blood
  - The surge of glucagon stimulates liver to release glucose stores by the breakdown of glycogen into glucose (glycogenolysis)
  - Also, glucagon stimulates the liver to produce glucose (gluconeogenesis)

Regulation of Glucose

- Beta Cells (β) release *insulin* (antagonistic to glucagon) to control blood glucose level
  - Insulin ↑ the rate at which various body cells take up glucose ⇨ insulin lowers the blood glucose level
  - Promotes glycogenesis - storage of glycogen in the liver
  - Insulin is rapidly broken down by the liver and must be secreted constantly

Regulation of Glucose

- Delta Cells (∂) produce *somatostatin,* which inhibits both glucagon and insulin
  - inhibits insulin and glucagon secretion by the pancreas
  - inhibits digestion by inhibiting secretion of digestive enzymes
  - inhibits gastric motility
  - inhibits absorption of glucose in the intestine

Regulation of Glucose

- Breakdown of sugars carried out by enzymes in the GI system
  - As simple sugars, they are absorbed from the GI system into the body
- To be converted into energy, glucose must first be transmitted through the cell membrane
  - Glucose molecule is too large and does not readily diffuse

Regulation of Glucose

- Glucose must pass into the cell by binding to a special carrier protein on the cell's surface.
  - *Facilitated diffusion* - carrier protein binds with the glucose and carries it into the cell.
- The rate at which glucose can enter the cell is dependent upon insulin levels
  - Insulin serves as the messenger - travels via blood to target tissues
  - Combines with specific insulin receptors on the surface of the cell membrane

Regulation of Glucose

- Body strives to maintain blood glucose between 60 mg/dl and 120 mg/dl.
- Glucose
  - brain is the biggest user of glucose in the body
  - sole energy source for brain
  - brain does not require insulin to utilize glucose

Regulation of Glucose

Glucagon and Insulin are opposites (antagonists) of each other.

Regulation of Glucose

- Glucagon
  - Released in response to:
    - Sympathetic stimulation
    - Decreasing blood glucose concentration
  - Acts primarily on liver to increase rate of glycogen breakdown
  - Increasing blood glucose levels have inhibitory effect on glucagon secretion

Regulation of Glucose

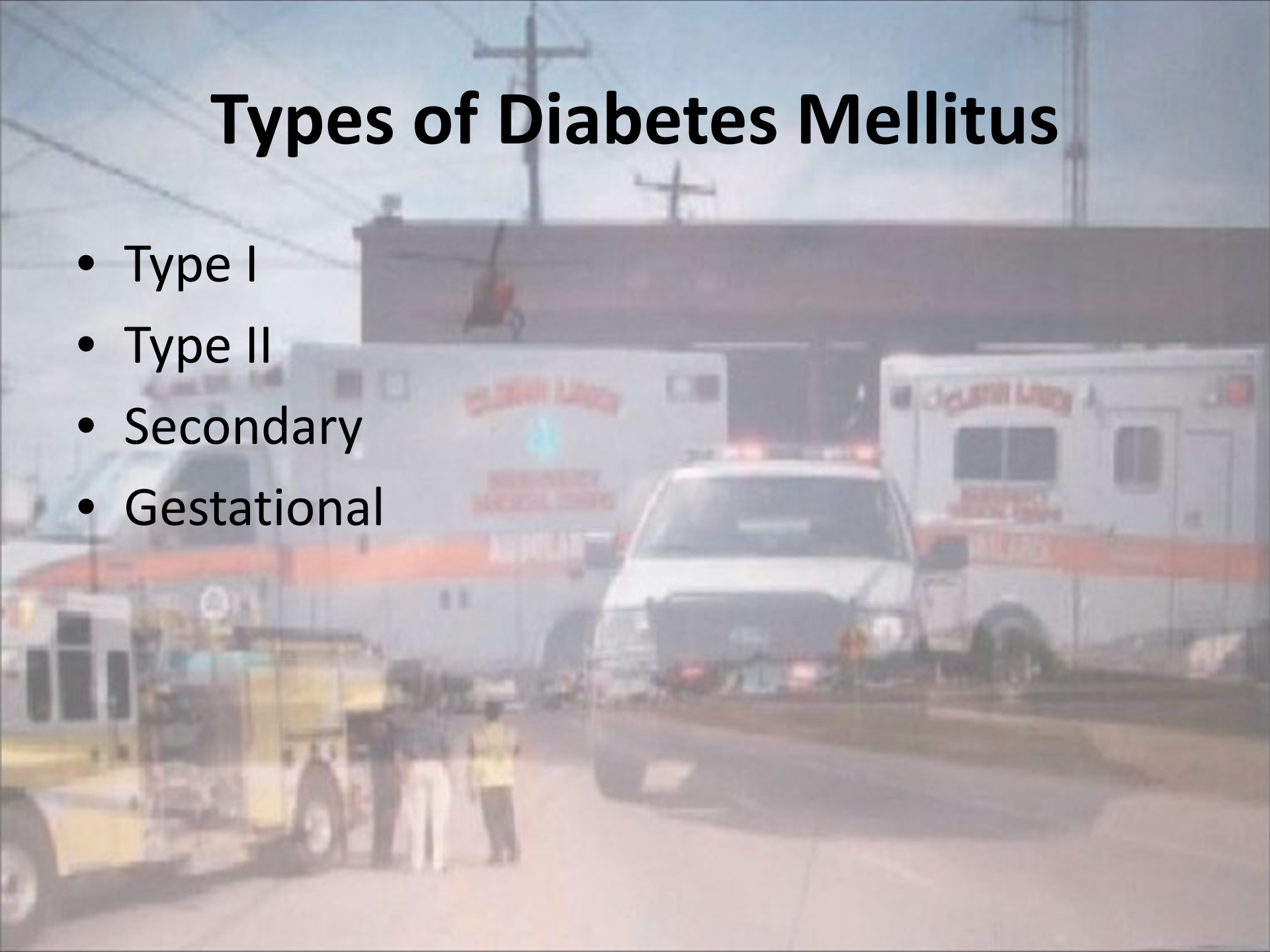
- Insulin
  - Released in response to:
    - Increasing blood glucose concentration
    - Parasympathetic innervation
  - Acts on cell membranes to increase glucose uptake from blood stream
  - Promotes facilitated diffusion of glucose into cells

Diabetes Mellitus

- 2 Types historically based on age of onset (NOT insulin vs. non-insulin)
  - Type I
    - juvenile onset
    - insulin dependent
  - Type II
    - historically adult onset
      - now some morbidly obese children are developing Type II diabetes
    - non-insulin dependent
      - may progress to insulin dependency

Types of Diabetes Mellitus

- Type I
- Type II
- Secondary
- Gestational



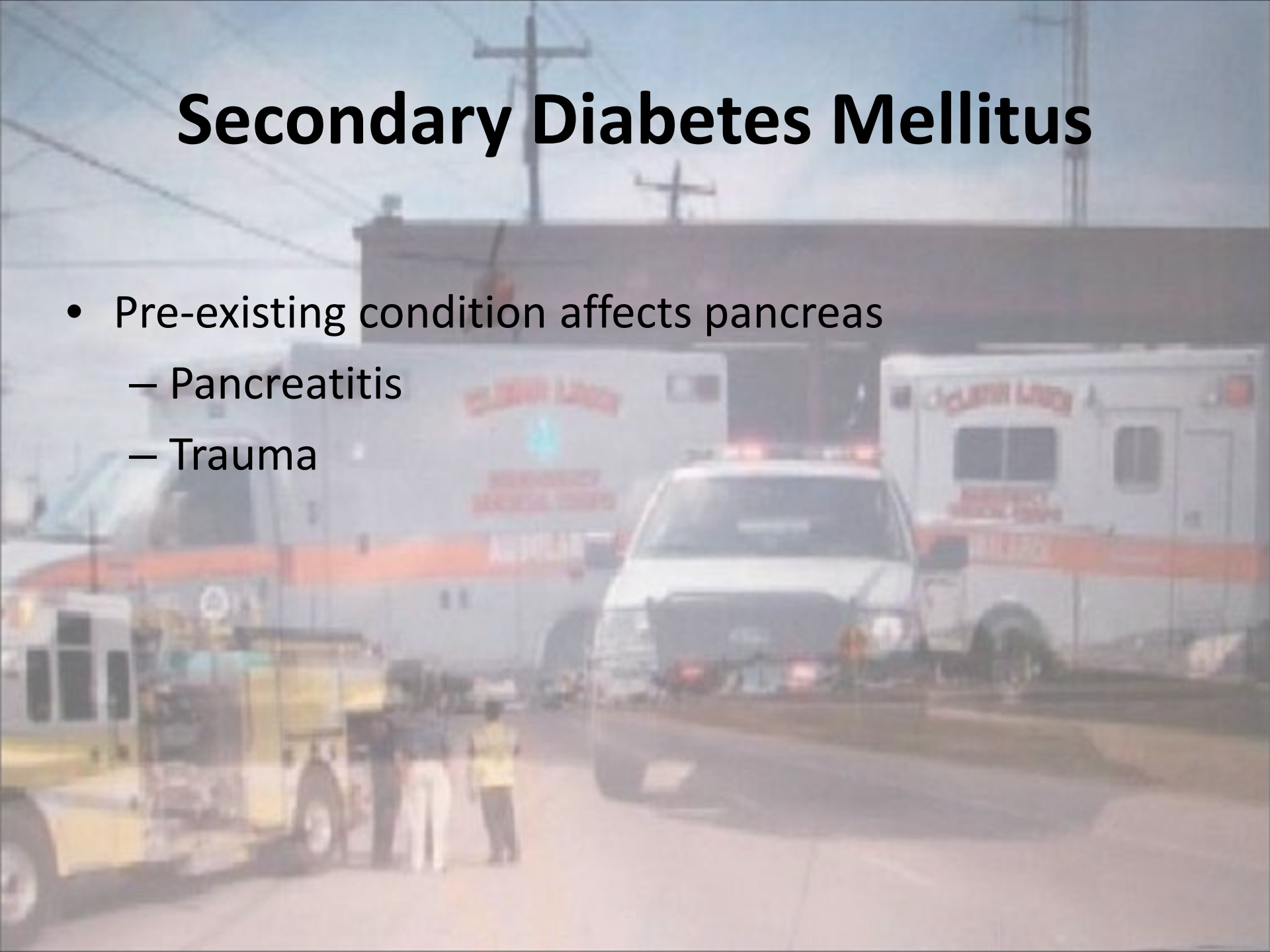
Pathophysiology of Type I Diabetes Mellitus

- Characterized by inadequate or absent production of insulin by pancreas
- Usually presents by age 25
- Strong genetic component
- Autoimmune features
  - body destroys own insulin-producing cells in pancreas
  - may follow severe viral illness or injury
- Requires lifelong treatment with insulin replacement

Pathophysiology of Type II Diabetes Mellitus

- Pancreas continues to produce some insulin however disease results from combination of:
  - Relative insulin deficiency
  - Decreased sensitivity of insulin receptors
- Onset usually after age 25 in overweight adults
  - Some morbidly obese children develop Type II diabetes
- Familial component
- Usually controlled with diet, weight loss, oral hypoglycemic agents
  - Insulin may be needed at some point in life

Secondary Diabetes Mellitus



- Pre-existing condition affects pancreas
  - Pancreatitis
  - Trauma

Gestational Diabetes Mellitus

- Occurs during pregnancy
  - Usually resolves after delivery
- Occurs rarely in non-pregnant women on BCPs
- Increased estrogen, progesterone antagonize insulin

Presentation of New Onset Diabetes Mellitus

- 3 Ps
  - Polyuria
  - Polydipsia
  - Polyphagia
- Blurred vision, dizziness, altered mental status
- Rapid weight loss
- Warm dry skin,
- Weakness, Tachycardia, Dehydration

Long Term Treatment of Diabetes Mellitus

- Diet regulation
  - *e.g*. 1400 calorie ADA diet
- Exercise
  - increase patient's glucose metabolism
- Oral hypoglycemic agents
  - Sulfonylureas
- Insulin
  - Historically produced from pigs (porcine insulin)
  - Currently genetic engineering has lead to human insulin (Humulin)

Long Term Treatment of Diabetes Mellitus

- Insulin
  - Available in various forms distinguished on onset and duration of action
    - Onset
      - rapid (Regular, Semilente, Novolin 70/30)
      - intermediate (Novolin N, Lente)
      - slow (Ultralente)
    - Duration
      - short, 5-7 hrs (Regular)
      - intermediate, 18-24 hrs (Semilente, Novolin N, Lente, NPH)
      - long-acting, 24 - 36+ hrs (Novolin 70/30, Ultralente)

Long Term Treatment of Diabetes Mellitus

- Insulin
  - Must be given by injection as insulin is protein which would be digested if given orally
    - extremely compliant patients may use an insulin pump which provides a continuous dose
    - current research studying inhaled insulin form

Long Term Treatment of Diabetes Mellitus

- Oral Hypoglycemic Agents
  - Stimulate the release of insulin from the pancreas, thus patient must still have intact *beta* cells in the pancreas.
  - Common agents include:
    - Glucotrol® (glipizide)
    - Micronase® or Diabeta® (glyburide)
    - Glucophage® (metformin) [Not a sulfonylurea]

Emergencies Associated Blood Glucose Level

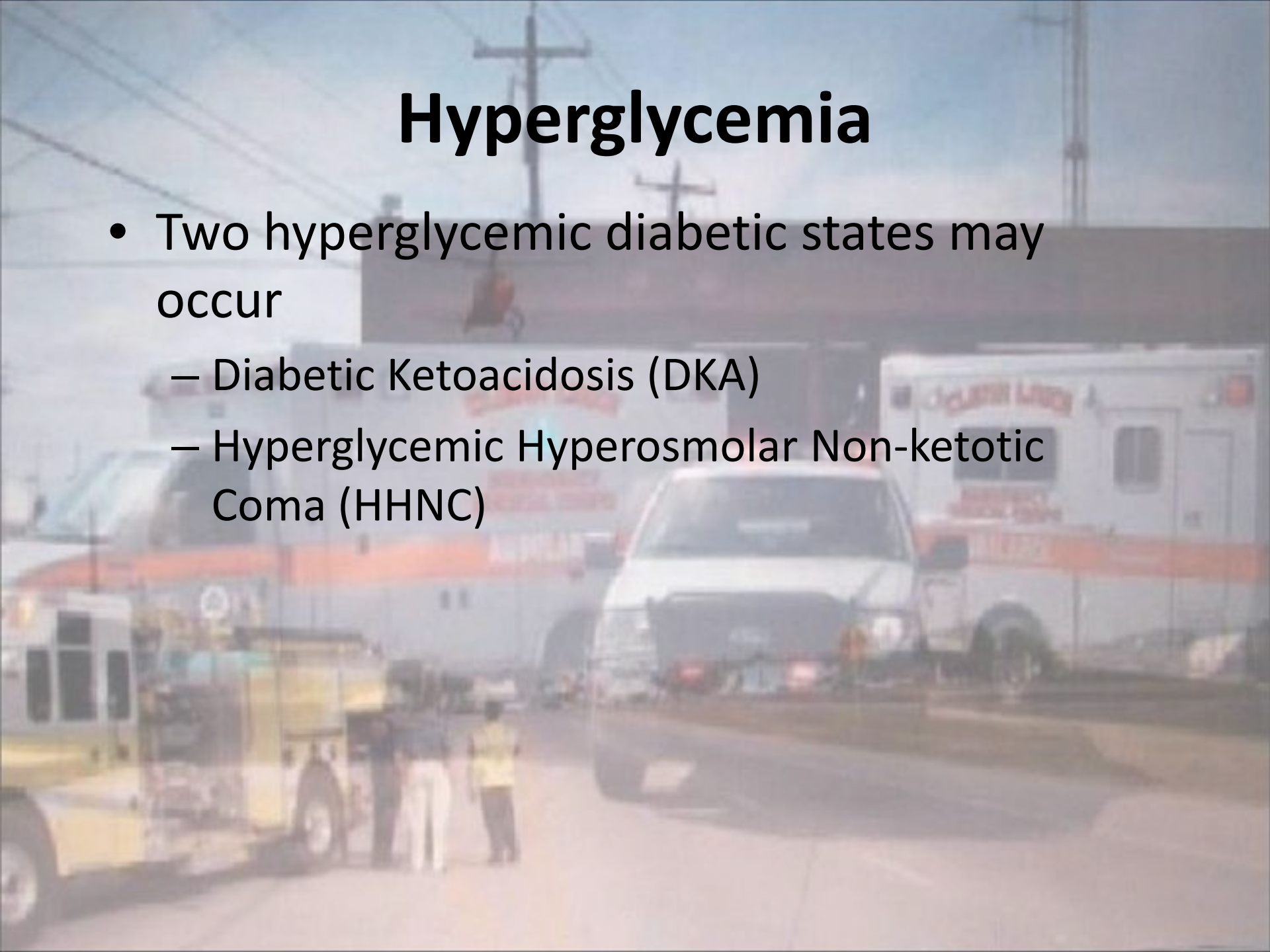
- Hyperglycemia
  - Diabetic Ketoacidosis (DKA)
  - Hyperglycemic Hyperosmolar Nonketotic Coma (HHNC)
- Hypoglycemia
  - “Insulin Shock”

Hyperglycemia

- Defined as blood glucose > 200 mg/dl
- Causes
  - Failure to take *medication* (insulin)
  - Increased *dietary* intake
  - *Stress* (surgery, MI, CVA, trauma)
  - Fever
  - *Infection*
  - *Pregnancy* (gestational diabetes)

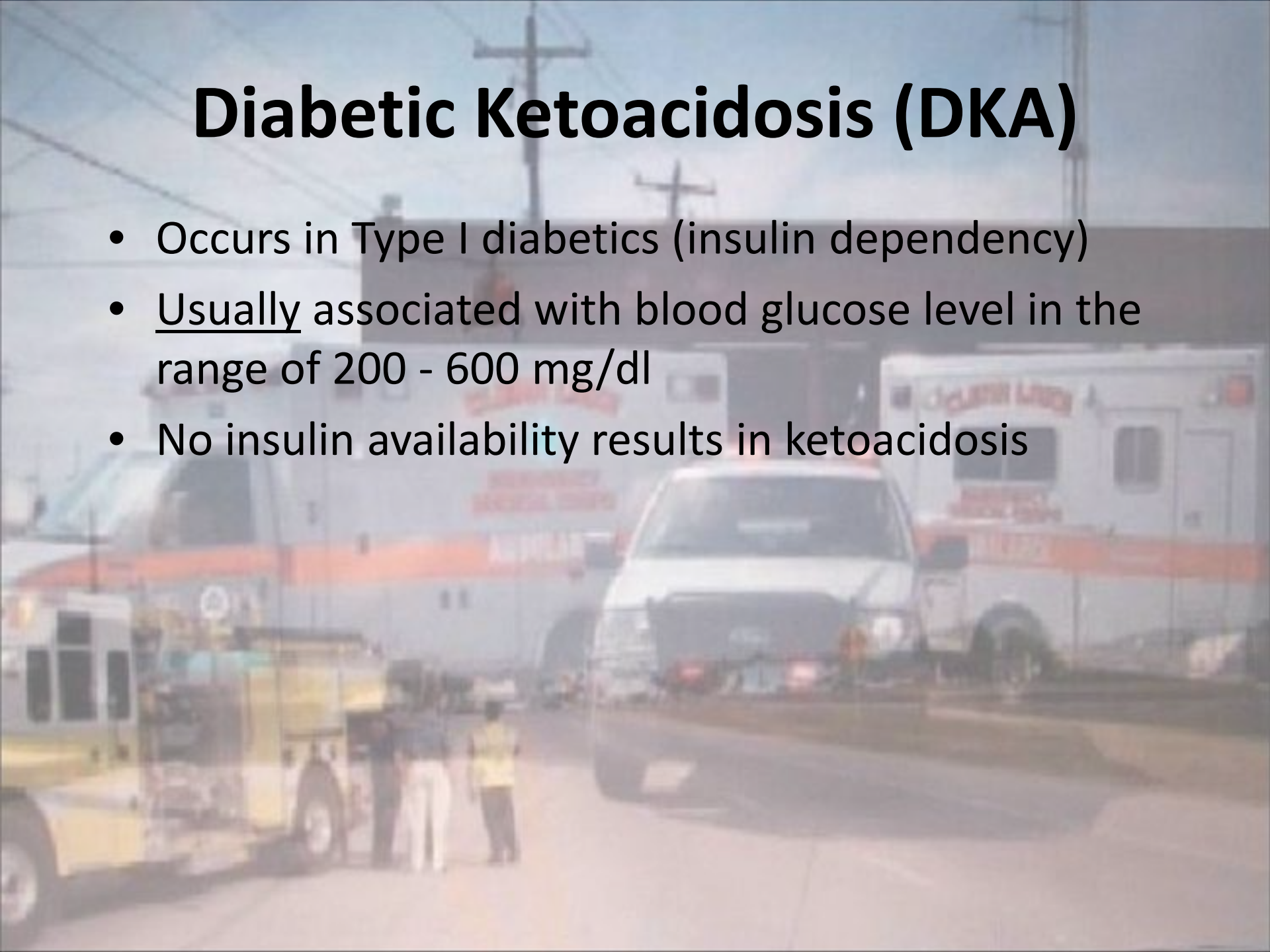
Hyperglycemia

- Two hyperglycemic diabetic states may occur
  - Diabetic Ketoacidosis (DKA)
  - Hyperglycemic Hyperosmolar Non-ketotic Coma (HHNC)



Diabetic Ketoacidosis (DKA)

- Occurs in Type I diabetics (insulin dependency)
- Usually associated with blood glucose level in the range of 200 - 600 mg/dl
- No insulin availability results in ketoacidosis



Diabetic Ketoacidosis (DKA)

- Pathophysiology
  - Results from absence of insulin
    - prevents glucose from entering the cells
    - leads to glucose accumulation in the blood
  - Cells become starved for glucose and begin to use other energy sources (primarily fats)
    - Fat metabolism generates fatty acids
    - Further metabolized into ketoacids (ketone bodies)

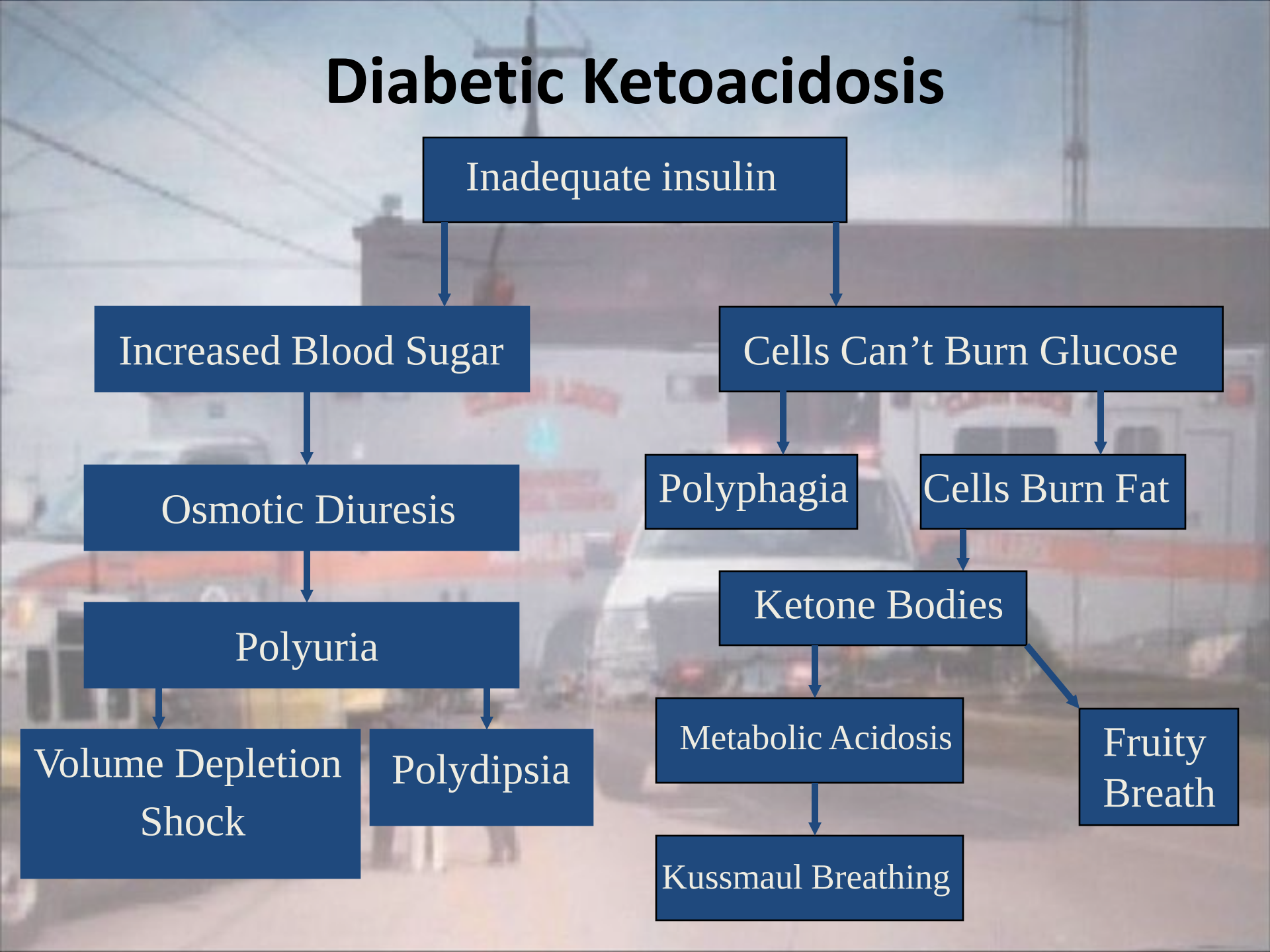
Diabetic Ketoacidosis (DKA)

- Pathophysiology (cont)
  - Blood sugar rises above renal threshold for reabsorption (blood glucose > 180 mg/dl)
    - glucose “spills” into the urine
    - Loss of glucose in urine causes osmotic diuresis
  - Results in
    - dehydration
    - acidosis
    - electrolyte imbalances (especially K+)

Diabetic Ketoacidosis (DKA)

- Presentation
  - Gradual onset with progression
  - Warm, pink, dry skin
  - Dry mucous membranes (dehydrated)
  - Tachycardia, weak peripheral pulses
  - Weight loss
  - Polyuria (frequent urination)
  - Polydipsia (excessive thirst)
  - Abdominal pain with nausea/vomiting
  - Altered mental status
  - Kussmaul respirations with acetone (fruity) odor

Diabetic Ketoacidosis



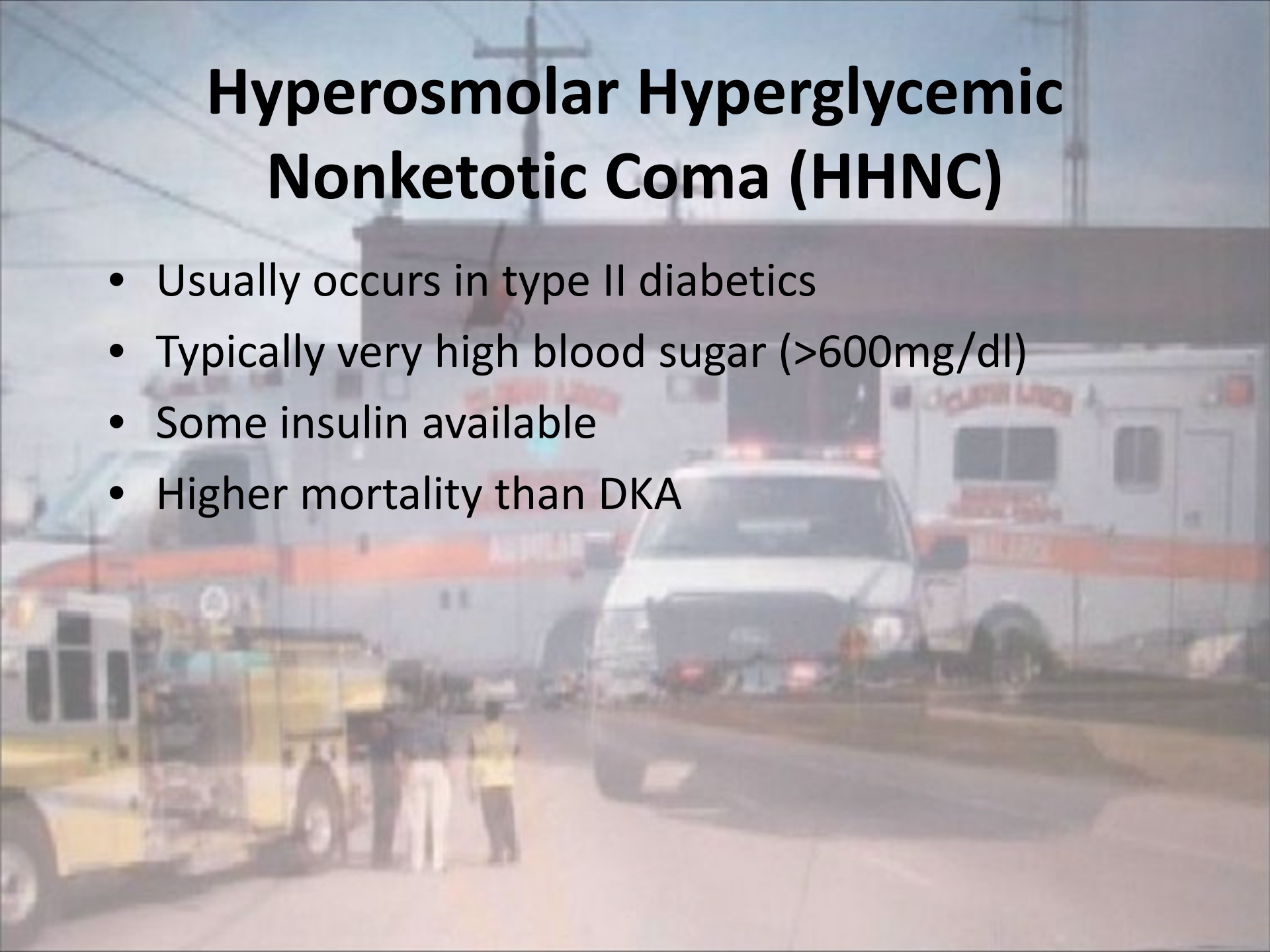
Management of DKA

- Airway/Ventilation/Oxygen NRB mask
- Assess blood glucose level & ECG
- IV access, large bore NS
  - normal saline bolus and reassess
  - often requires several liters
- Assess for underlying cause of DKA
- Transport

How does fluid treat DKA?

Hyperosmolar Hyperglycemic Nonketotic Coma (HHNC)

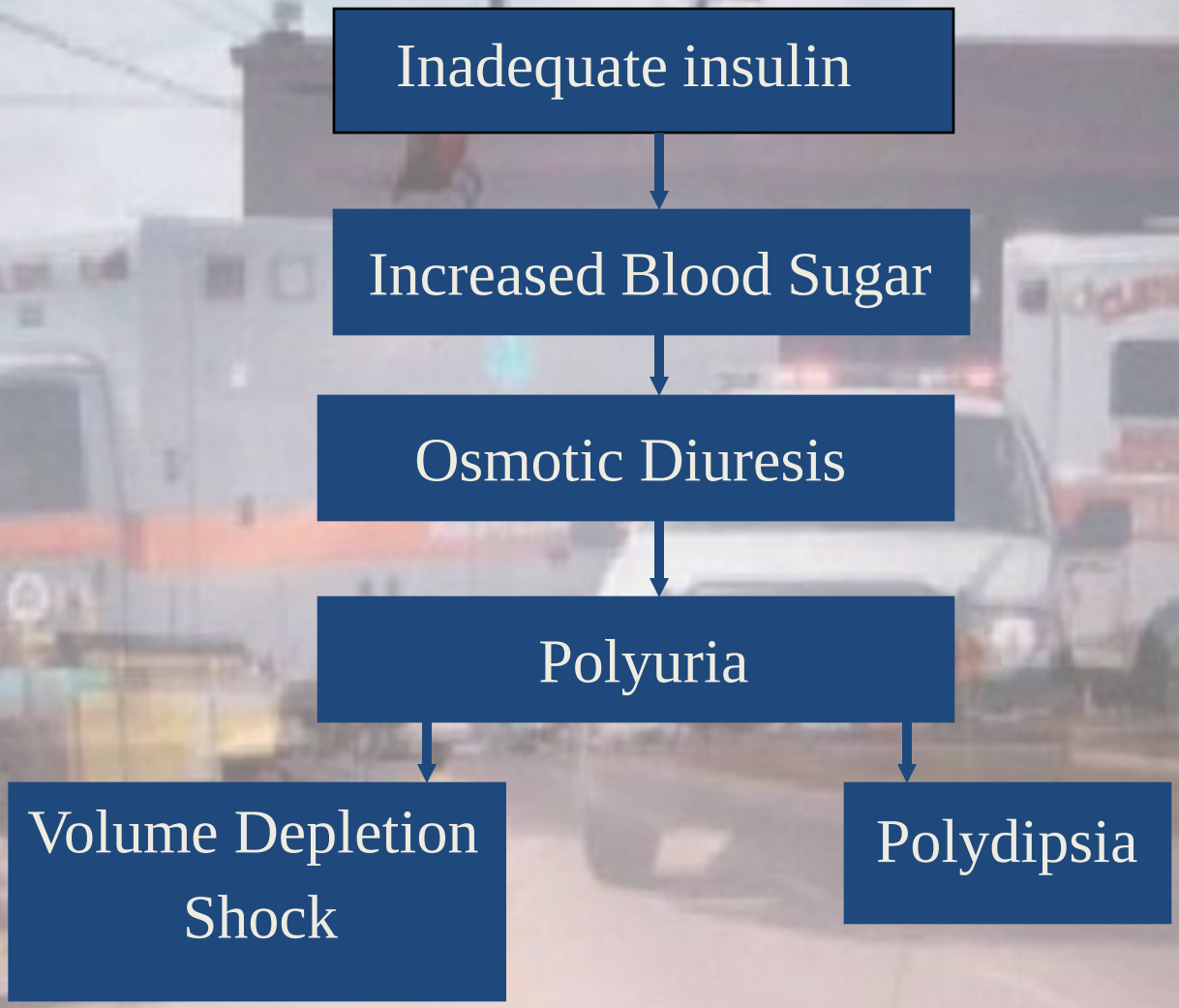
- Usually occurs in type II diabetics
- Typically very high blood sugar (>600mg/dl)
- Some insulin available
- Higher mortality than DKA



Hyperosmolar Hyperglycemic Nonketotic Coma (HHNC)

- Pathophysiology
  - Some minimal insulin production
    - enough insulin available to allow glucose to enter the cells and prevent ketogenesis
    - not enough to decrease gluconeogenesis by liver
    - no ketosis
  - Extreme hyperglycemia produces hyperosmolar state causing
    - diuresis
    - severe dehydration
    - electrolyte disturbances

Hyperosmolar Hyperglycemic Nonketotic Coma (HHNC)



Hyperosmolar Hyperglycemic Nonketotic Coma (HHNC)

- Presentation
  - Same as DKA but with greater severity
    - Higher blood glucose level
    - Non-insulin dependent diabetes
    - Greater degree of dehydration

Management of HHNC

- Secure airway and assess ventilation
  - Consider need to assist ventilation
  - Consider need to intubate
- High concentration oxygen
- Assess blood glucose level & ECG
- IV access, large bore NS
  - normal saline bolus and reassess
  - often requires several liters
- Assess for underlying cause of HHNC
- Transport

Further Management of Hyperglycemia

- Insulin (regular)
  - Correct hyperglycemia
- Correction of acid/base imbalances
  - Bicarbonate (severe cases documented by ABG)
- Normalization of electrolyte balance
  - DKA may result in hyperkalemia 2^{o} to acidosis
    - H^{+} shifts intracellularly, K^{+} moves to extracellular space
  - Urinary K^{+} losses may lead to hypokalemia once therapy is started

Hypoglycemia

- True hypoglycemia defined as blood sugar < 60 mg/dl
- ALL hypoglycemia is NOT caused by diabetes
  - Can occur in non-diabetic patients
    - thin young females
    - alcoholics with liver disease
    - alcohol consumption on empty stomach will block glucose synthesis in liver (gluconeogenesis)
- Hypoglycemia causes impaired functioning of brain which relies on constant supply of glucose

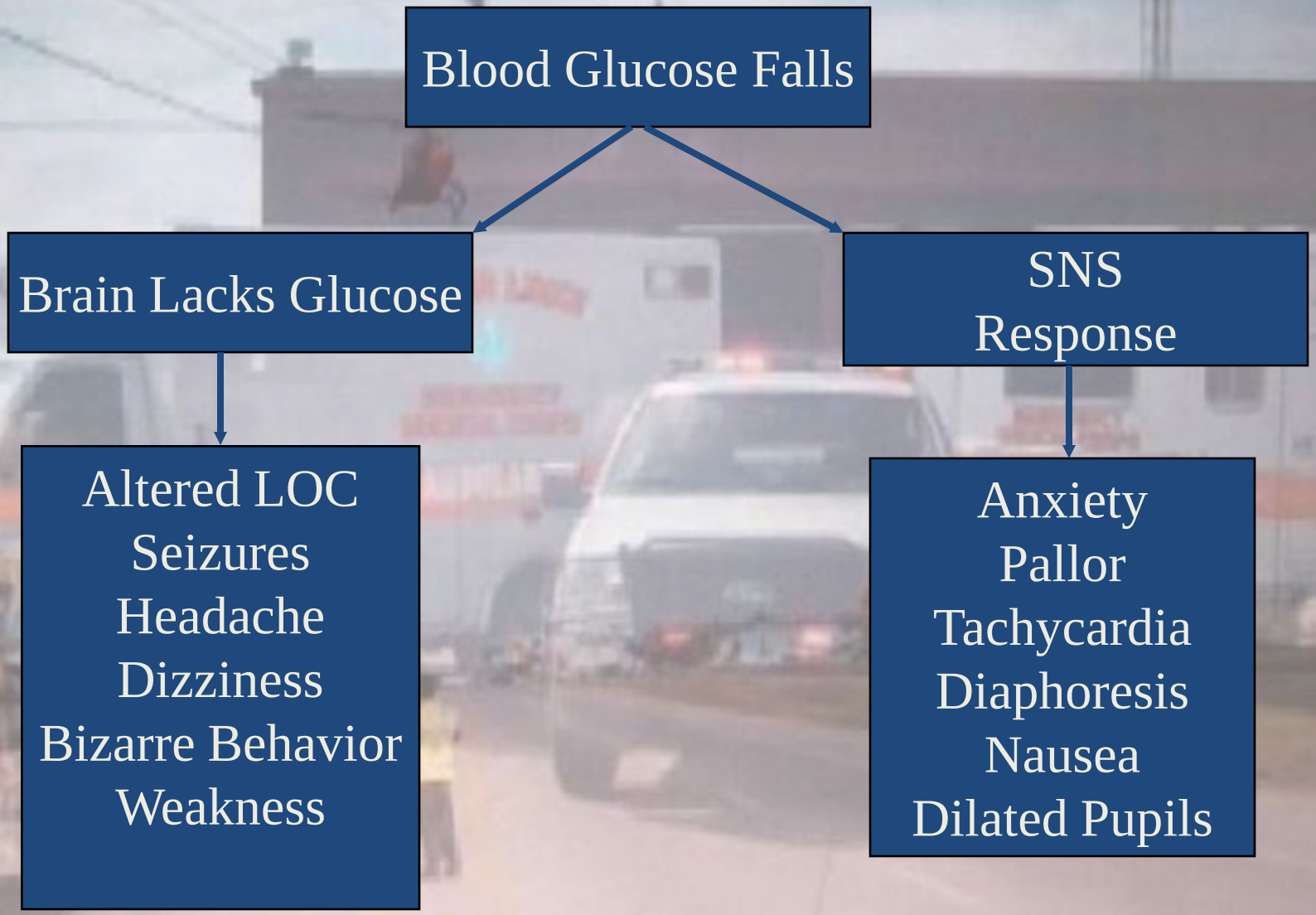
Hypoglycemia

- Causes of hypoglycemia in diabetics
  - Too much insulin
  - Too much oral hypoglycemic agent
    - Long half-life requires hospitalization
  - Decreased dietary intake (took insulin and missed meal)
  - Vigorous physical activity
- Pathophysiology
  - Inadequate blood glucose available to brain and other cells resulting from one of the above causes

Hypoglycemia

- Presentation
  - Hunger (initially), Headache
  - Weakness, Incoordination (*mimics a stroke*)
  - Confusion, Unusual behavior
    - may appear intoxicated
  - Seizures
  - Coma
  - Weak, rapid pulse
  - Cold, clammy skin
  - Nervousness, trembling, irritability

Hypoglycemia: Pathophysiology



Hypoglycemia

Beta Blockers may mask symptoms by inhibiting sympathetic response

Management of Hypoglycemia

- Secure airway manually
  - suction prn
  - Ventilate prn
- High concentration oxygen
- Vascular access
  - Large bore IV catheter
  - Saline lock, D_5W or NS
  - Large proximal vein preferred
- Assess blood glucose level

Management of Hypoglycemia

- Oral glucose
  - ONLY if intact gag reflex, awake & able to sit up
  - 15gm-30gm of packaged glucose, or
  - May use sugar-containing drink or food
  - Oral route often slower
- Intravenous glucose
  - Adult: Dextrose 50% (D_{50}) 25gms IV in patent, free-flowing vein, may repeat
  - Children: Dextrose 25% (D_{25}) @ 2 - 4 cc/kg (0.5 - 1 gm/kg) [Infants - may choose Dextrose 10% @ 0.5 - 1 gm/kg or 5 - 10 cc/kg]

Management of Hypoglycemia

- Glucagon
  - Used if unable to obtain IV access
  - 1 mg IM
  - Requires glycogen stores
  - slower onset of action than IV route

What persons are likely to have *inadequate* glycogen stores?

Management of Hypoglycemia

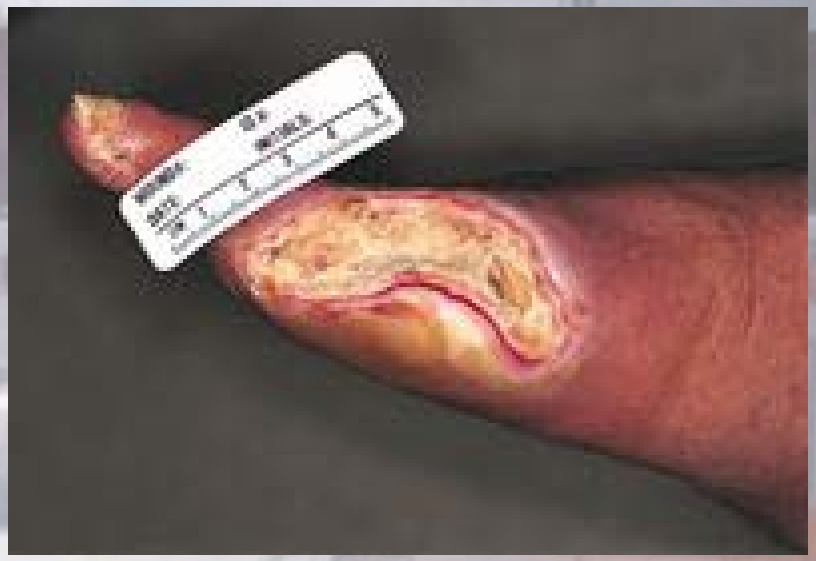
- Have patient eat high-carbohydrate meal
- Transport?
  - Patient Refusal
    - Leave only with responsible family/friend for 6 hours
    - Must educate family/friend to hypoglycemic signs/symptoms
    - Advise to contact personal physician
  - Transport
    - Hypoglycemic patients on oral agents (long half life)
    - Unknown, atypical or untreated cause of hypoglycemia

Long-term Complications of Diabetes Mellitus

- Blindness
  - Retinal hemorrhages
- Renal Disease
- Peripheral Neuropathy
  - Numbness in “stocking glove” distribution (hands and feet)
- Heart Disease and Stroke
  - Chronic state of Hyperglycemia leads to early atherosclerosis
- Complications in Pregnancy

Long-term Complications of Diabetes Mellitus

- <u>Diffuse Atherosclerois</u>
  - AMI
  - CVA
  - PVD
    - Hypertension
  - Renal failure
  - Diabetic retinopathy/blindness
  - Gangrene



Long-term Complications of Diabetes Mellitus

Diabetics are up to 4 times more likely to have heart disease and up to 6 times more likely to have a stroke than a non-diabetic

10% of all diabetics develop renal disease usually resulting in dialysis

Long-term Complications of Diabetes Mellitus

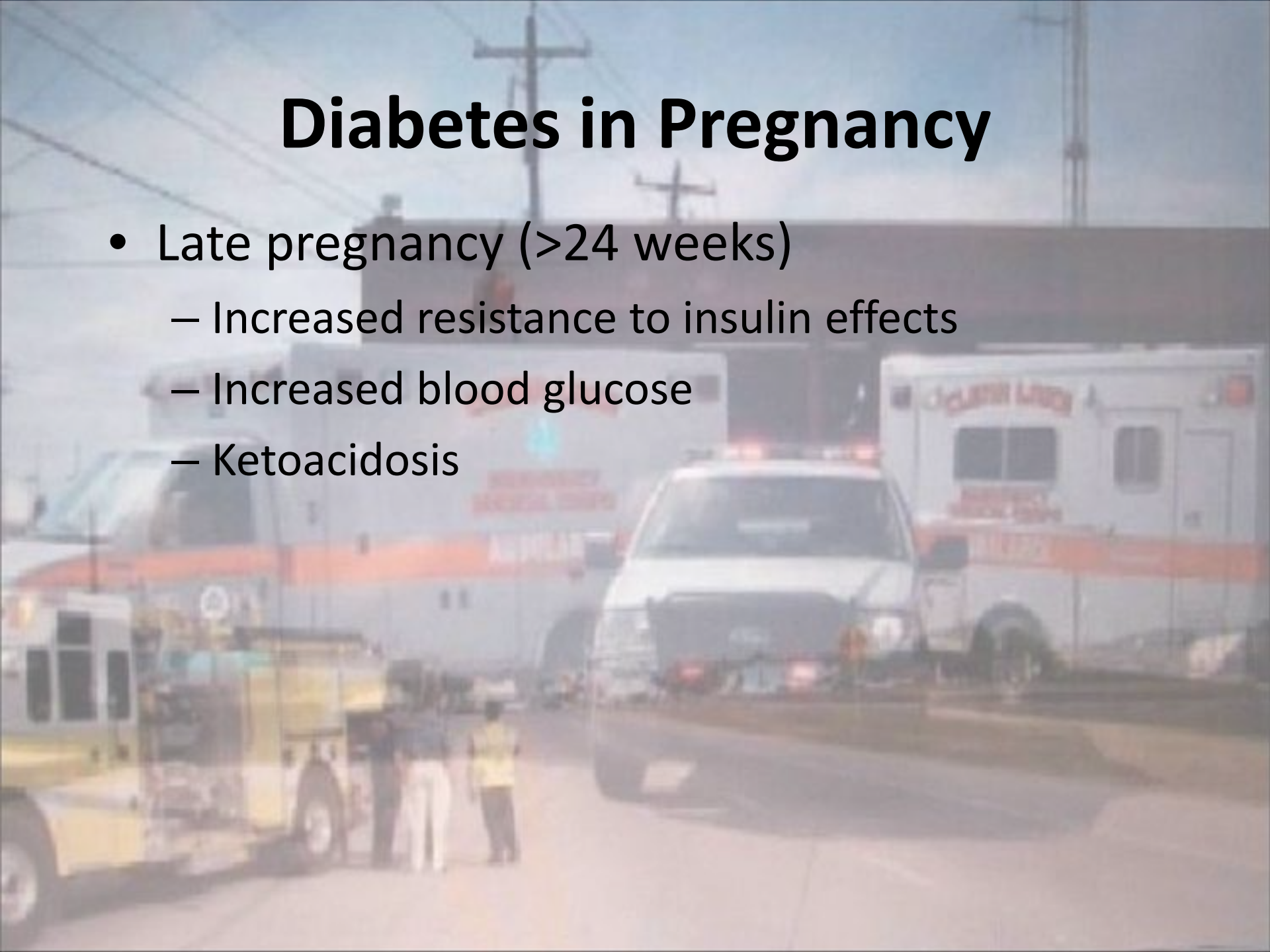
- Peripheral Neuropathy
  - Silent MI
    - Vague, poorly-defined symptom complex
      - Weakness
      - Dizziness
      - Malaise
      - Confusion
    - Suspect MI in any diabetic with MI signs/symptoms with or without CP

Diabetes in Pregnancy

- Early pregnancy (<24 weeks)
  - Rapid embryo growth
  - Decrease in maternal blood glucose
  - Episodes of hypoglycemia

Diabetes in Pregnancy

- Late pregnancy (>24 weeks)
  - Increased resistance to insulin effects
  - Increased blood glucose
  - Ketoacidosis

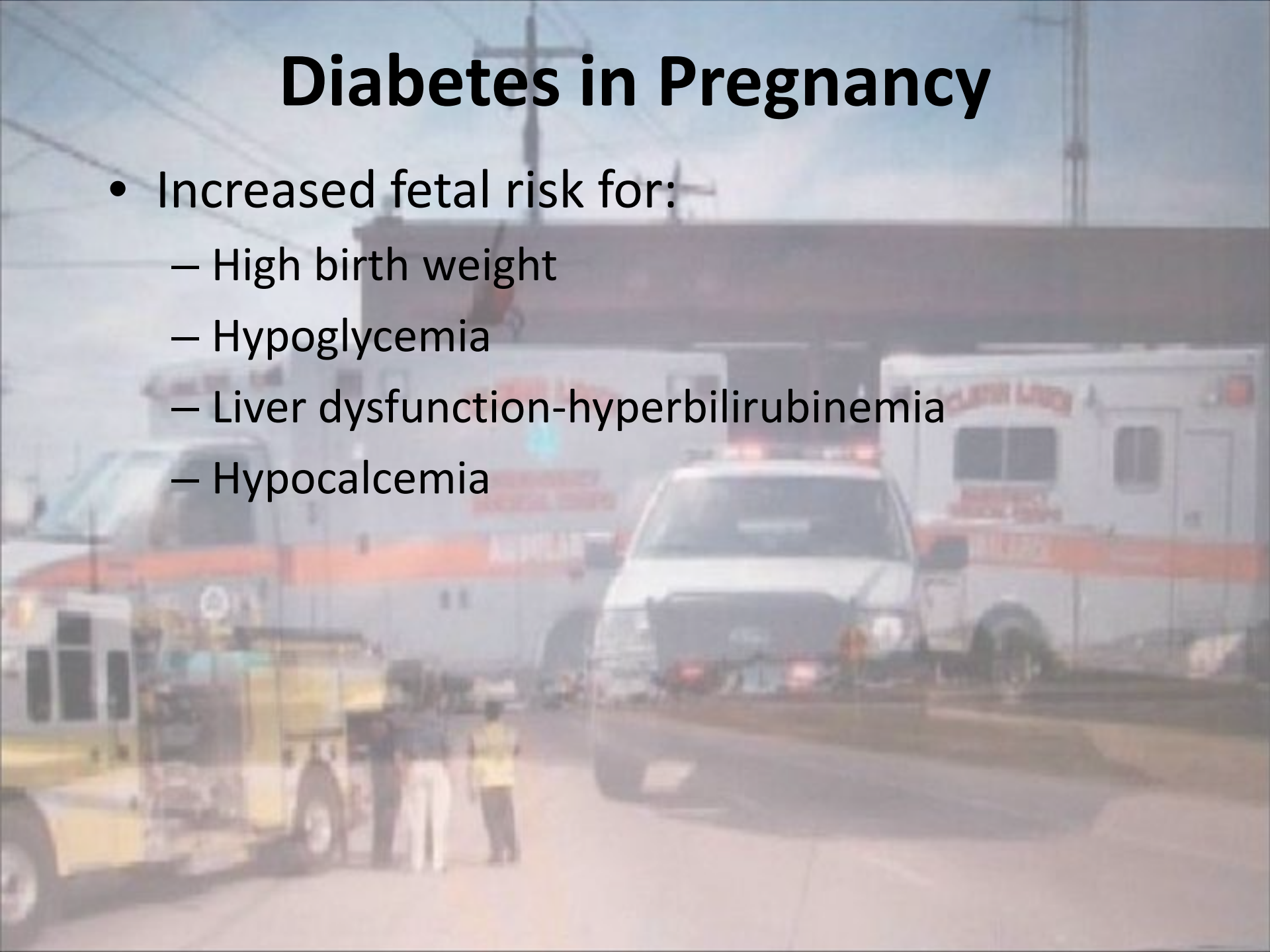


Diabetes in Pregnancy

- Increased maternal risk for:
  - Pregnancy-induced hypertension
  - Infections
    - Vaginal
    - Urinary tract

Diabetes in Pregnancy

- Increased fetal risk for:
  - High birth weight
  - Hypoglycemia
  - Liver dysfunction-hyperbilirubinemia
  - Hypocalcemia



Assessment of the Diabetic Patient

- Maintain high-degree of suspicion
- Assess blood glucose level in all patients with
  - seizure, neurologic S/S, altered mental status
  - vague history or chief complaint
- Blood glucose assessment IS NOT necessary in all patients with diabetes mellitus!!

Assessment of the Diabetic Patient

- History and Physical Exam includes
  - Look for insulin syringes, medical alert tag, glucometer, or insulin (usually kept in refrigerator)
  - Last meal and last insulin dose
  - Missed med or missed meal?
  - Signs of infection
    - Foot cellulitis / ulcers
  - Recent illness or physiologic stressors

Blood Glucose Assessment

- Capillary vs. venous blood sample
  - Depends on glucometer model
  - Usually capillary preferred
- Dextrostick vs Glucometer
  - Dextrostick - colorimetric assessment of blood provides glucose estimate
  - Glucometer - quantitative glucose measurement
- Neonatal blood
  - Many glucometers are not accurate for neonates

This Concludes Diabetes Mellitus

Please visit the link below to take the EXAM

If you have any questions please contact:

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