

Acute Trauma Care: the changing focus from survival to functional outcome

Avery B. Nathens MD MPH, Professor
Departments of Surgery & Health Policy, Management, and Evaluation,
University of Toronto & Sunnybrook Health Sciences Centre
Medical Director, ACS TQIP



Today in Canada....



- ~10,000 will be injured
- 580 will be hospitalized
- 171 will be permanently partly disabled
- 13 will be totally disabled
- 37 people will die

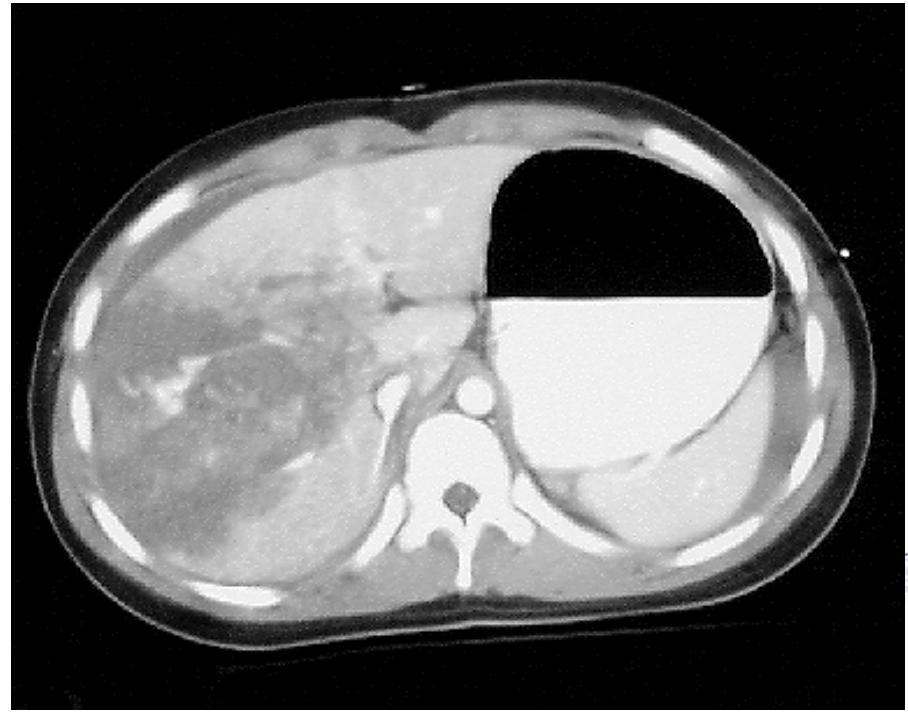
Leading cause of death among persons aged 1-34 and the fourth leading cause of death after cancer, heart, and respiratory diseases





Surgery
UNIVERSITY OF TORONTO





UNTO

Myth busting

- Public opinion poll – 1000 Ontarians
 - 78% believed their local hospital can care for life threatening injuries
 - 40% believed *all patients* can receive trauma center care within 1 hr of a 911 call



[Enlarge this image](#)

HEALTH CARE

Ontarians overestimate access to trauma care, specialist's poll shows

JULIEN RUSSELL BRUNET

From Thursday's Globe and Mail

Published Friday, Jul. 29, 2011 3:00AM EDT

Last updated Friday, Jul. 29, 2011 4:11AM EDT



Surgery
UNIVERSITY OF TORONTO



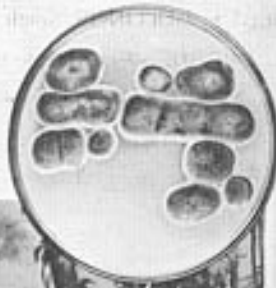


American Civil War: 1861
Mortality: 25%
Transport time: 72 hrs
Factors: +/- ambulance

WW I: 1914
Mortality: 8.6%
Transport time: 8 hrs
Factors: ambulance (motorized)



Thanks to PENICILLIN
...He Will Come Home!



World War II: 1939

Mortality: 4.5%

Transport time: 4 hrs

Factors: Ambulance, Medics,
Plasma, Antibiotics



Surgery
UNIVERSITY OF TORONTO



Korean War: 1951
Mortality: 2.5%
Transport time: 1.25 hrs
Factors: Helicopter, MASH



Viet Nam War: 1965-1972

Mortality 1.9%

Transport time: 27 minutes

Factors: Helicopter, Medics, Fixed wing



circa 1947



A tale of two counties

West & Trunkey, 1979

- Orange County

- Trauma patients transported to nearest of 39 facilities

Preventable deaths: 43%

- San Francisco County

- Trauma patients transported to 1 centrally located trauma facility

Preventable deaths: 1%



The NEW ENGLAND JOURNAL of MEDICINE

SPECIAL ARTICLE

N Engl J Med 2006;354:366-78.

A National Evaluation of the Effect of Trauma-Center Care on Mortality

Ellen J. MacKenzie, Ph.D., Frederick P. Rivara, M.D., M.P.H.,
Gregory J. Jurkovich, M.D., Avery B. Nathens, M.D., Ph.D.,
Katherine P. Frey, M.P.H., Brian L. Egleston, M.P.P., David S. Salkever, Ph.D.,
and Daniel O. Scharfstein, Sc.D.

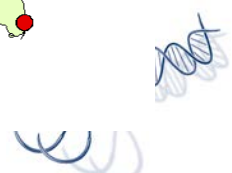
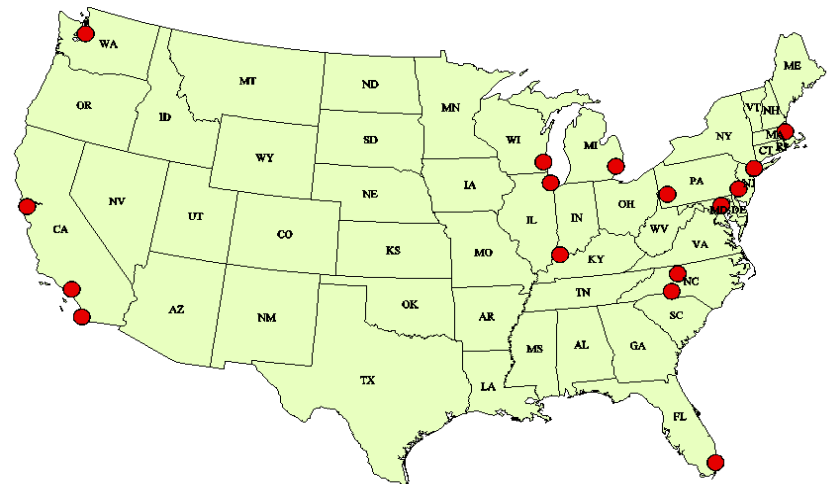


Surgery
UNIVERSITY OF TORONTO



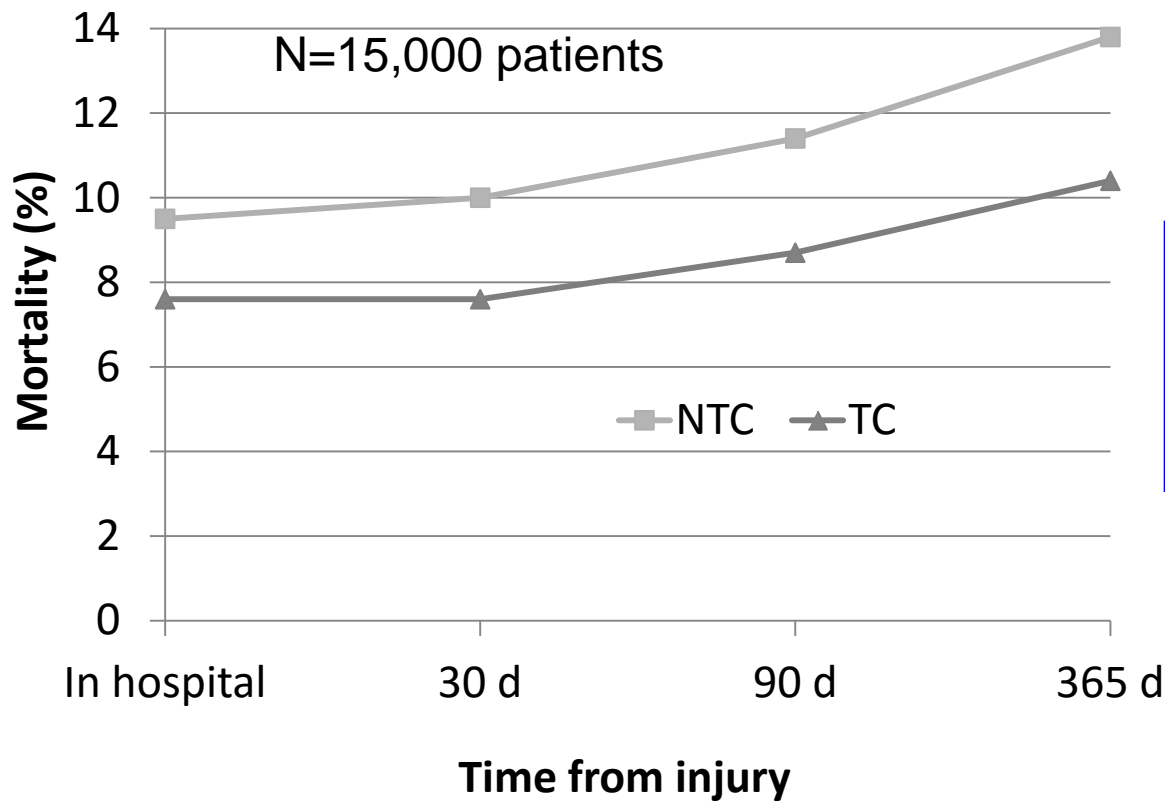
NSCOT -National Study of Cost and Outcomes in Trauma Care

- Prospective cohort study
- 18 level I trauma centers and 51 large non-designated centers in 15 urban regions
- Extensive data collection to allow for risk adjustment
 - Follow-up x 1 year



National Evaluation of the Effect of Trauma Center Care on Mortality

N Engl J Med, 2006



25% lower risk of death at one year in trauma centers



NSCOT

- Is trauma center care associated with better functional outcomes among survivors?
 - SF-36, functional capacity, return to work
 - Modest benefit (SF-36 scores) only among those with severe lower extremity trauma (J Bone Joint Surgery, 2008)
- Are trauma centers cost effective?
 - One year costs: \$80,232 in trauma centers vs \$58,320 in non-trauma centers
 - \$36,319 per life–year gained or \$790,931 per life saved
 - 50-100k per life year gained is considered acceptable



What is a Trauma Centre?

- Designation process
 - Occurs through a regional authority
 - Recognized in some way (EMS, financial) to receive trauma patients
- Accreditation (“verification”) process to ensure resources/procedures in place to provide care
 - External agency – Trauma Association of Canada/Accreditation Canada
- Designation does not ensure accreditation
 - SMH, SHSC designated in 1992
 - Accredited in 2006



Trauma Center Designation Levels

- Level I/II
 - Provides definitive care - urban
- Level III/IV/V
 - Initial care of major trauma - rural
 - Surgical capacity (Level III)
 - EM physicians (IV)
 - Nursing stations (V)



Ontario, Canada





- 15% of the population >100 km from a specialist
- 9 adult trauma centers



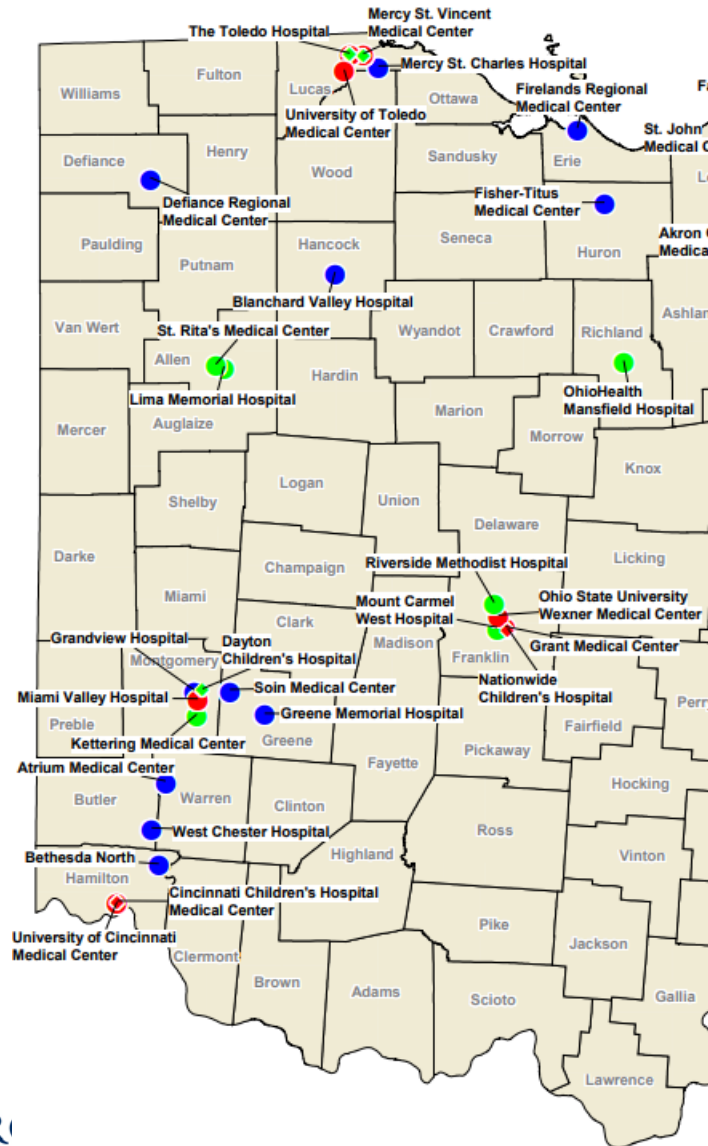
OHIO State Trauma System

Population: 12 million

Level 1 or 2: 22

Level 3: 20

42 trauma centres!



State Frog
Bullfrog

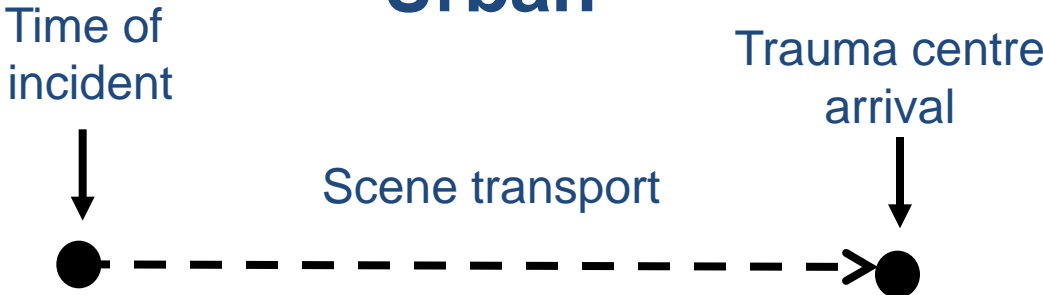


State Insect
Ladybug

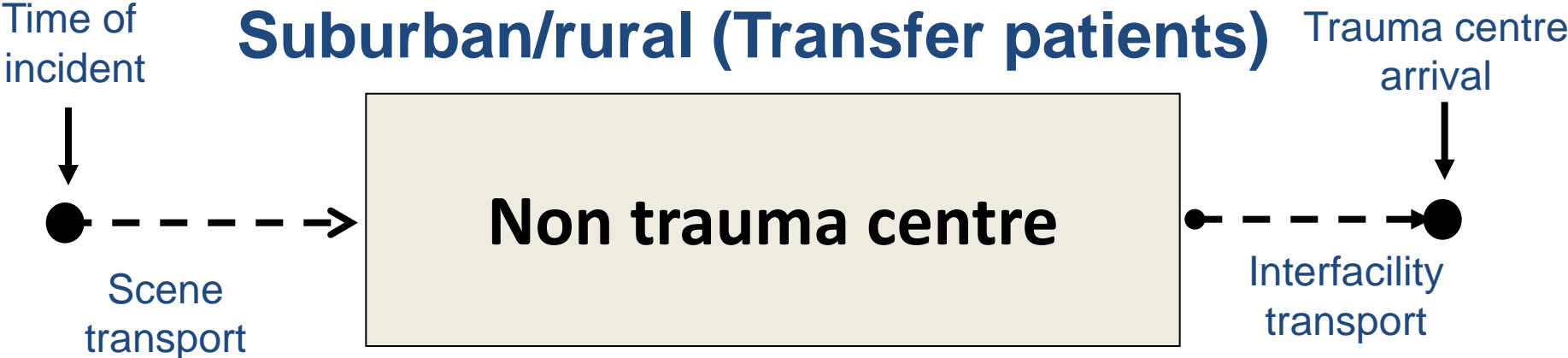


Routes to Trauma Centre Care

Urban



Suburban/rural (Transfer patients)





Surgery
UNIVERSITY OF TORONTO

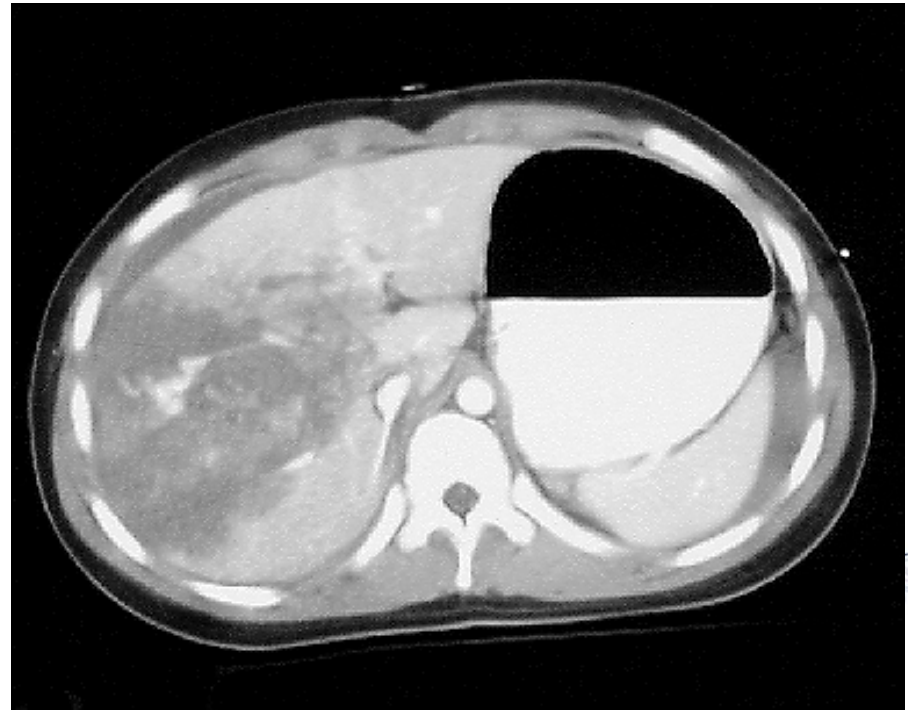
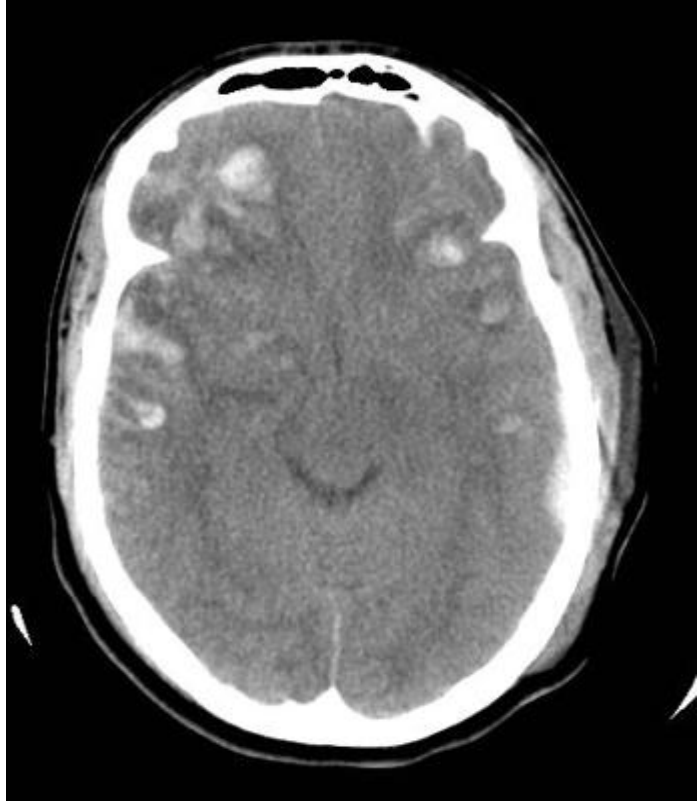


Trauma Team Activation



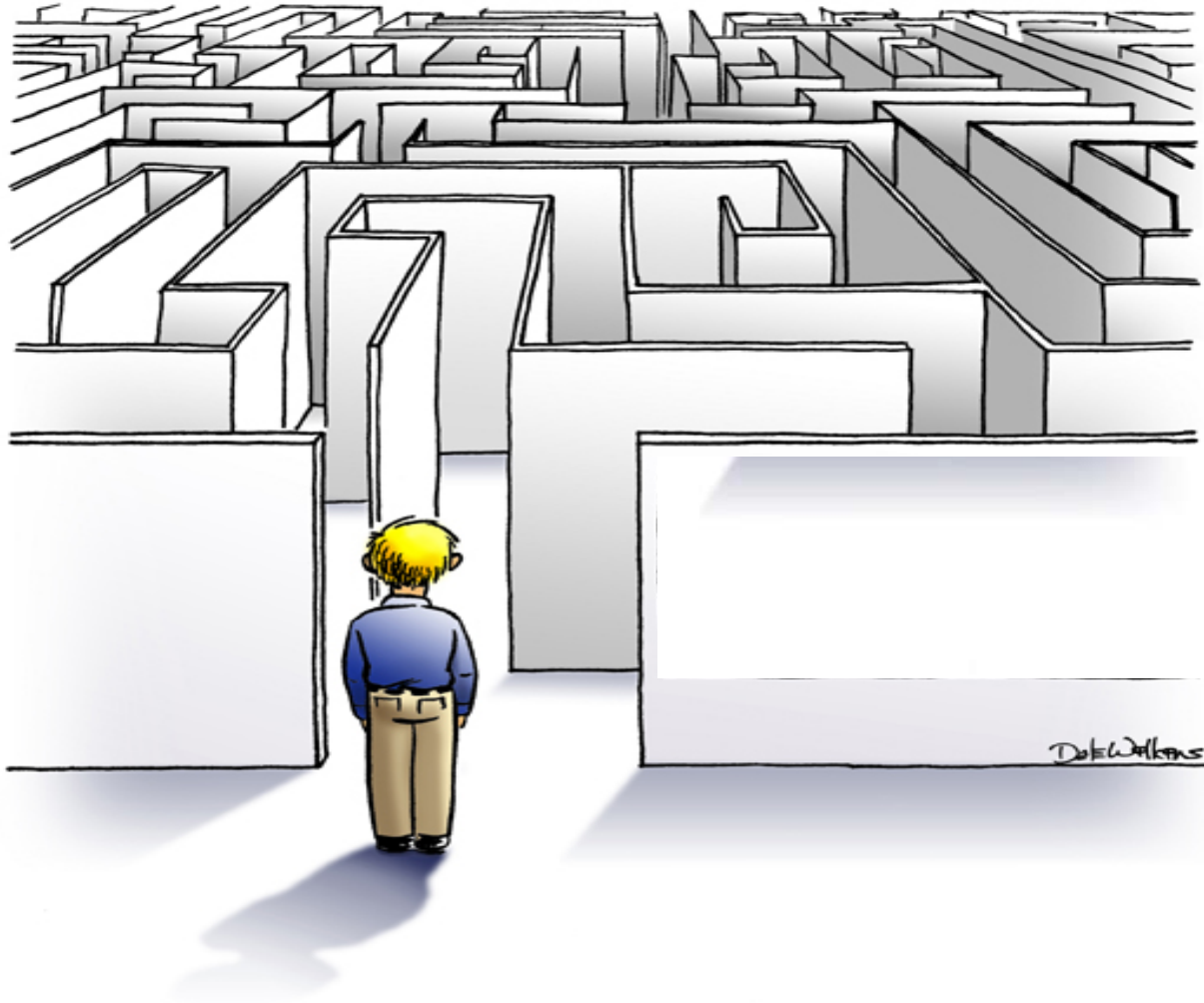
- Trauma team leader
- Anesthesia
- General Surgery
- Orthopaedic Surgery
- 2 nurses
- Respiratory therapist
- +/- Neurosurgery





UNTO

Priority setting?

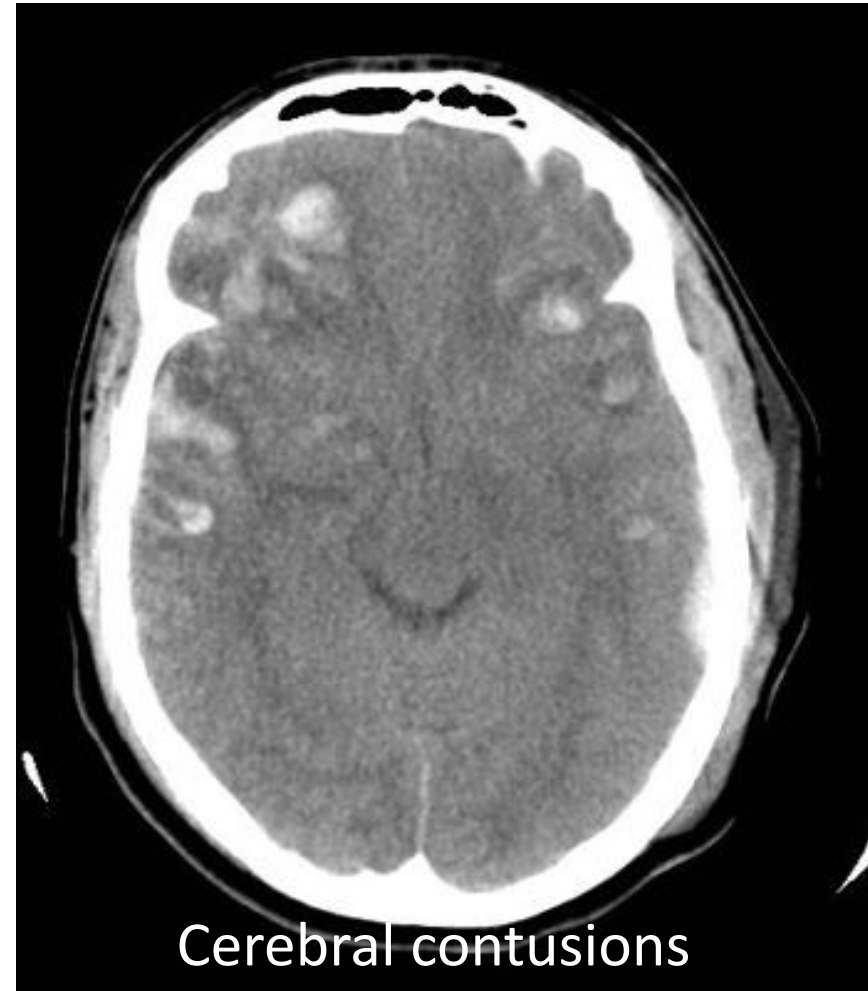
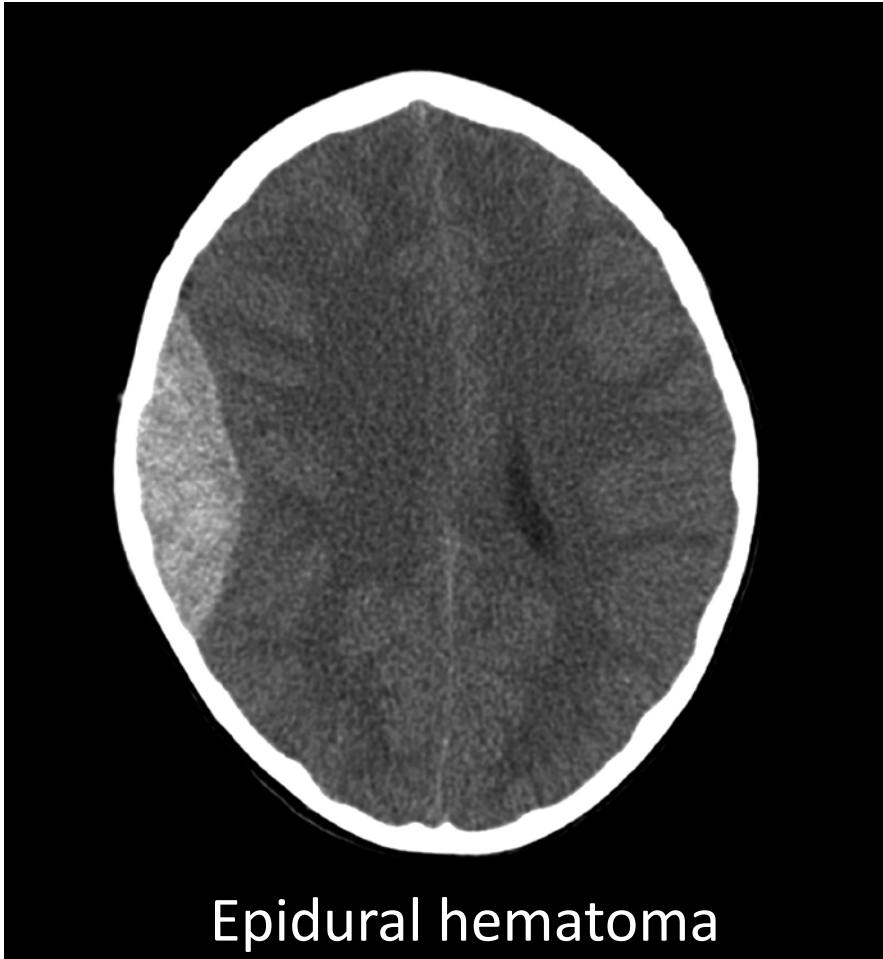


Trauma Priorities

- Airway
- Breathing
- Circulation/Hemorrhage
- Disability – Brain/spine
- Extremities



Severe TBI



Damage control surgery

- Damage control – originated in the US Navy, refers to the capacity of a ship to absorb damage and maintain mission integrity



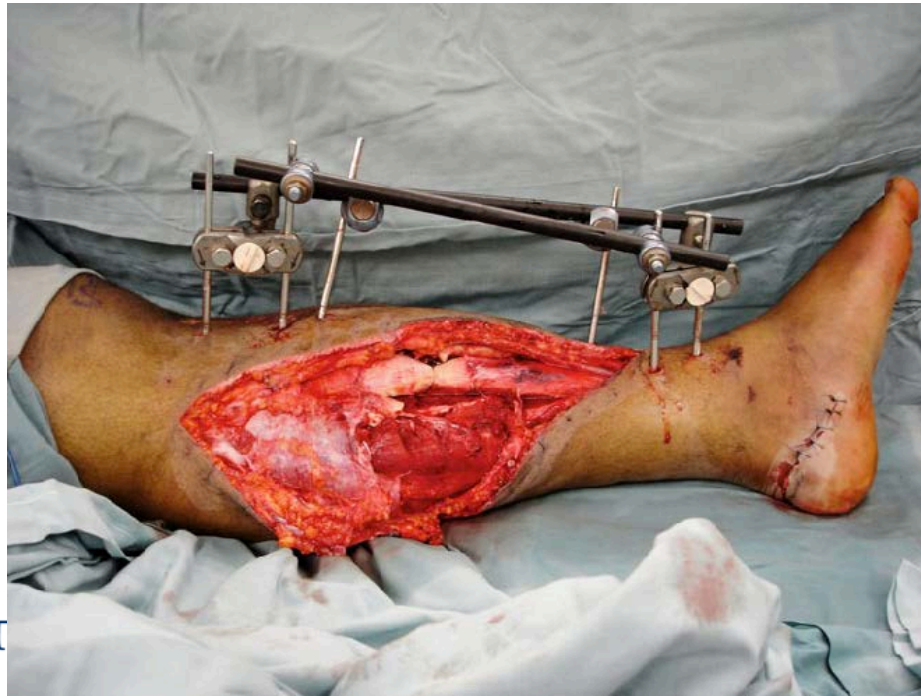
Damage control laparotomy

- Control bleeding
- Prevent contamination
- Pack the abdomen and leave open
- Resuscitate in the ICU
- “Live to fight another day”



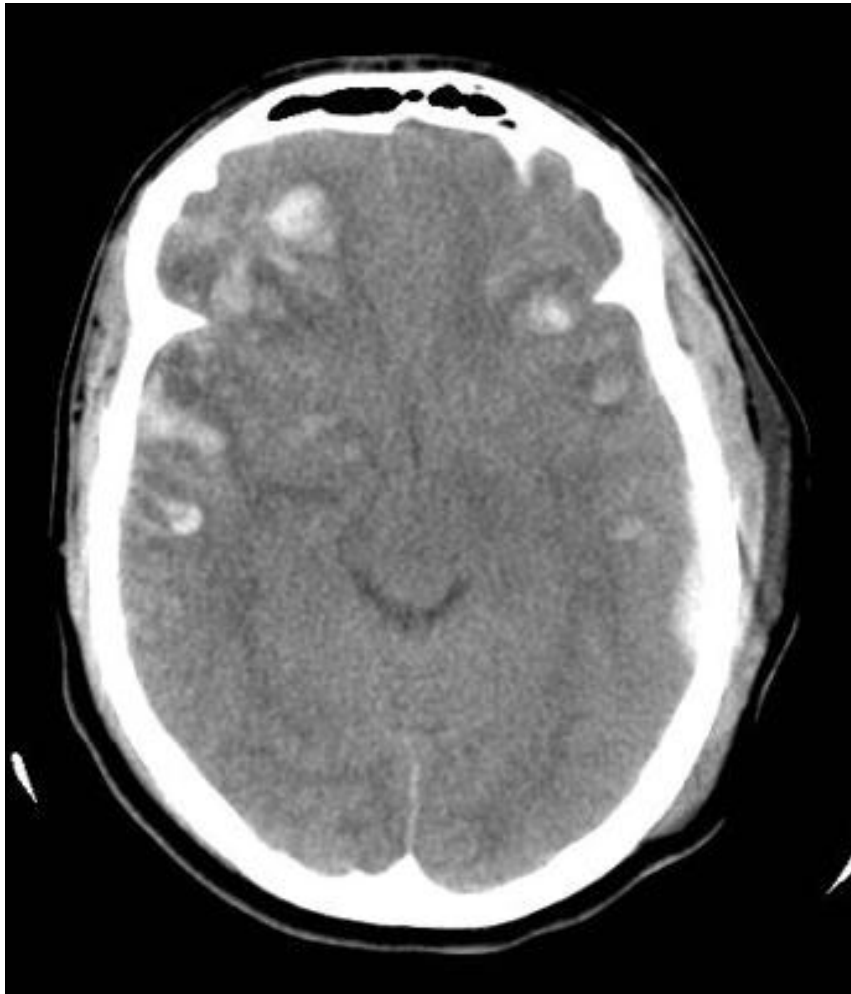
Damage control orthopedics

- Severe soft tissue damage
- Associated nerve/vascular injury
- Severely comminuted/open fractures
- Severe, multiple injuries with other priorities



Management of severe TBI

Goal: prevent secondary brain injury



- Ensure adequate cerebral blood flow and oxygenation
- Avoid hypotension, hypoxemia
- Treat high (>22 mm HG) intracranial pressure and maintain cerebral perfusion pressure $>60-70$



Management of increased ICP

- Tier I
 - Sedation/analgesia with short acting agents
 - CSF drainage
- Tier II
 - Hyperosmolar therapy (mannitol, hypertonic saline)
 - PaCO₂ goal 30 - 35 mmHg
 - Consider additional neuromonitoring (e.g., PbtO₂, SjvO₂, CBF)
 - Consider test bolus of a paralytic to lower ICP
- Tier III
 - Decompressive craniectomy
 - Paralytics if positive response to test bolus
 - Barbiturate or propofol coma
 - Hypothermia for “rescue”



CHALLENGES



Surgery
UNIVERSITY OF TORONTO





Surgery
UNIVERSITY OF TORONTO



Trauma ~ 1998

- 22 yo male, previously well
- multiple GSW to abdomen, presents in shock
- Laparotomy, 14 units of blood
 - Hepatorraphy, splenectomy, bowel resection
- ICU – 3 days
- Ward – 6 days, discharged home



Trauma - 2017

- 72 yo male, cleaning roof, falls
 - Atrial fibrillation, MI, on plavix and dabigatran
- Subdural hematoma, T-spine fracture, multiple rib fractures
- ICU -2 weeks, pneumonia, trach, acute renal failure,
 - Family meetings to discuss goals of care
- Ward – 4 weeks, course complicated by delirium, UGI bleed , decubitus ulcer
- Discharged to rehabilitation



Trauma center care & the elderly

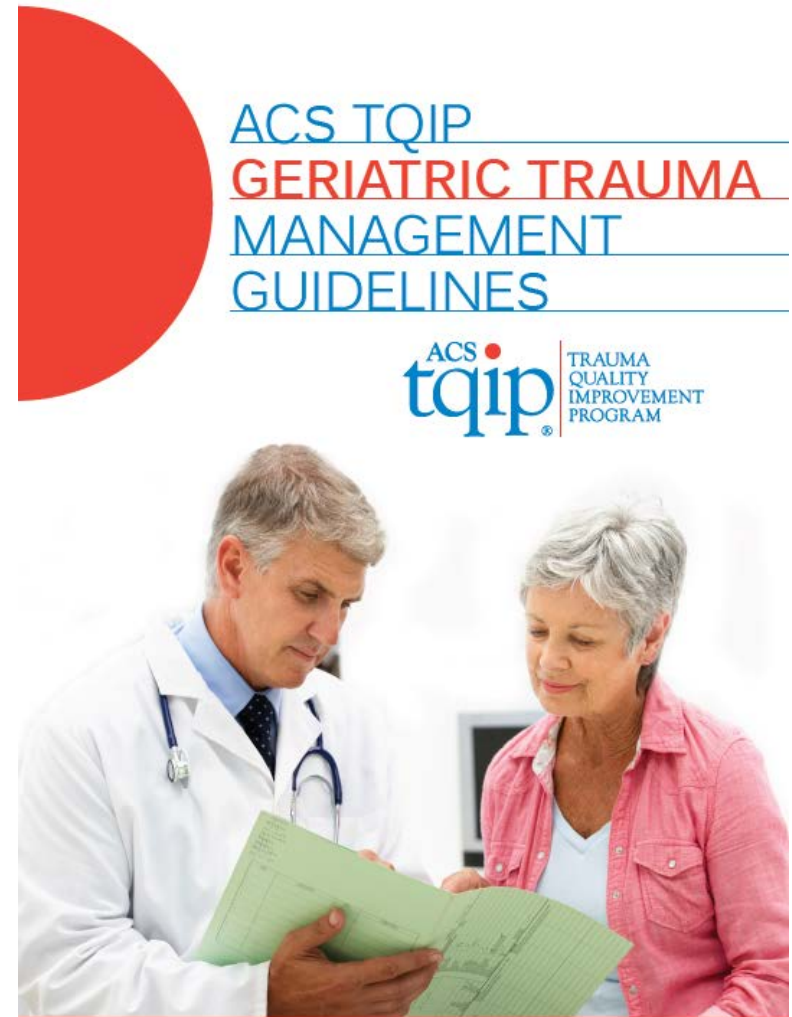
The unspoken NSCOT data

	Trauma center	Non-trauma center	Mortality reduction
Overall	7.6%	9.5%	20%
Age<55	5.9%	9.0%	34%
Age \geq 55	12.3%	13.1%	6% (NS)



Geriatric Best Practice Guidelines

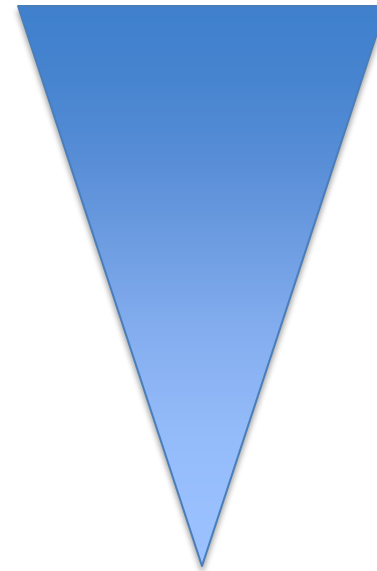
- Consolidation of existing recommendations and guidelines to provide concise, evidence-based, expert panel rated lists of protocols and practices to improve care of the elderly trauma patient.



Avoid the Hazards of Hospitalization

- Deconditioning
- Aspiration
- In-hospital falls
- Delirium (and complications of)
- Pressure sores
- Functional incontinence (family rejection)

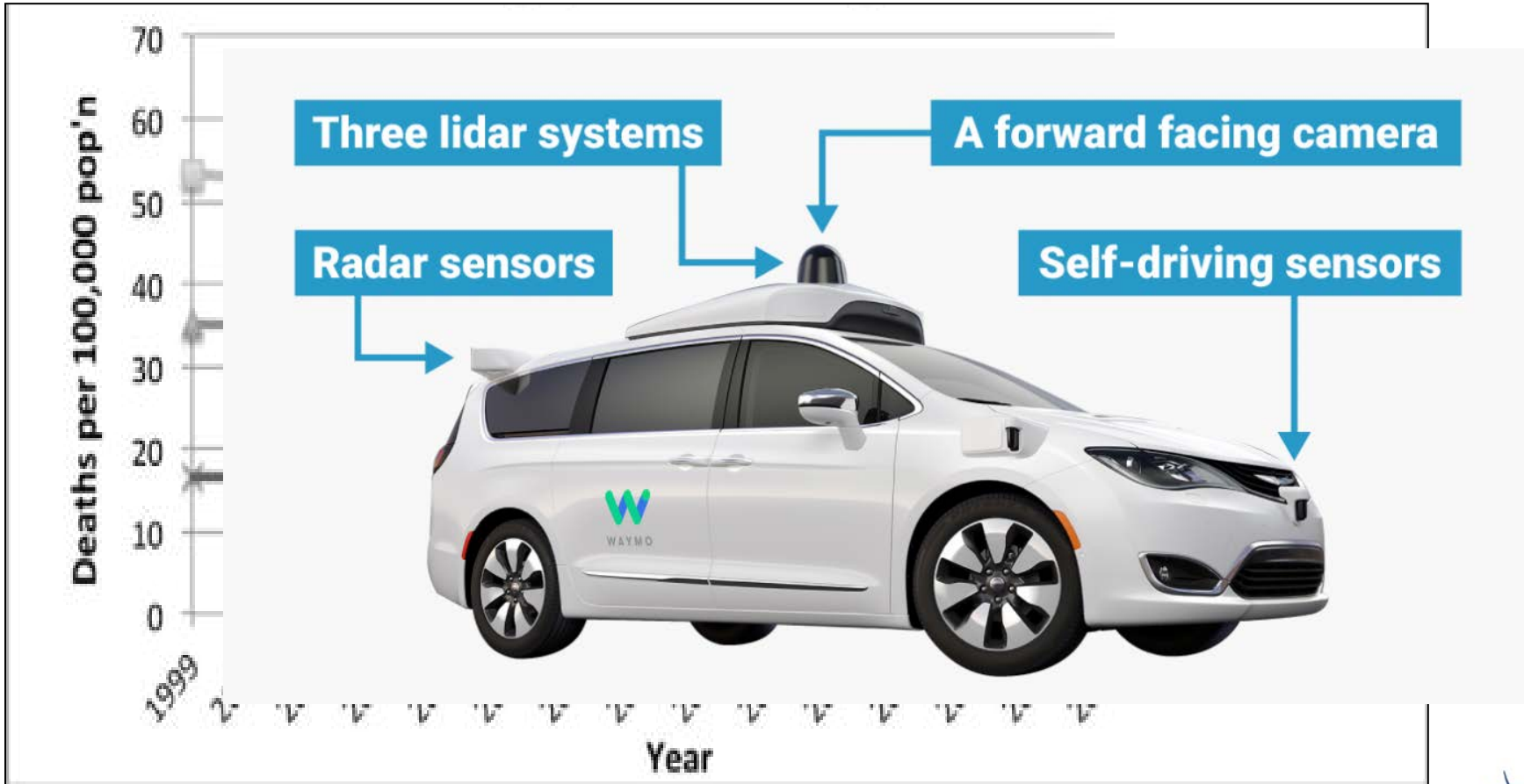
Functional independence



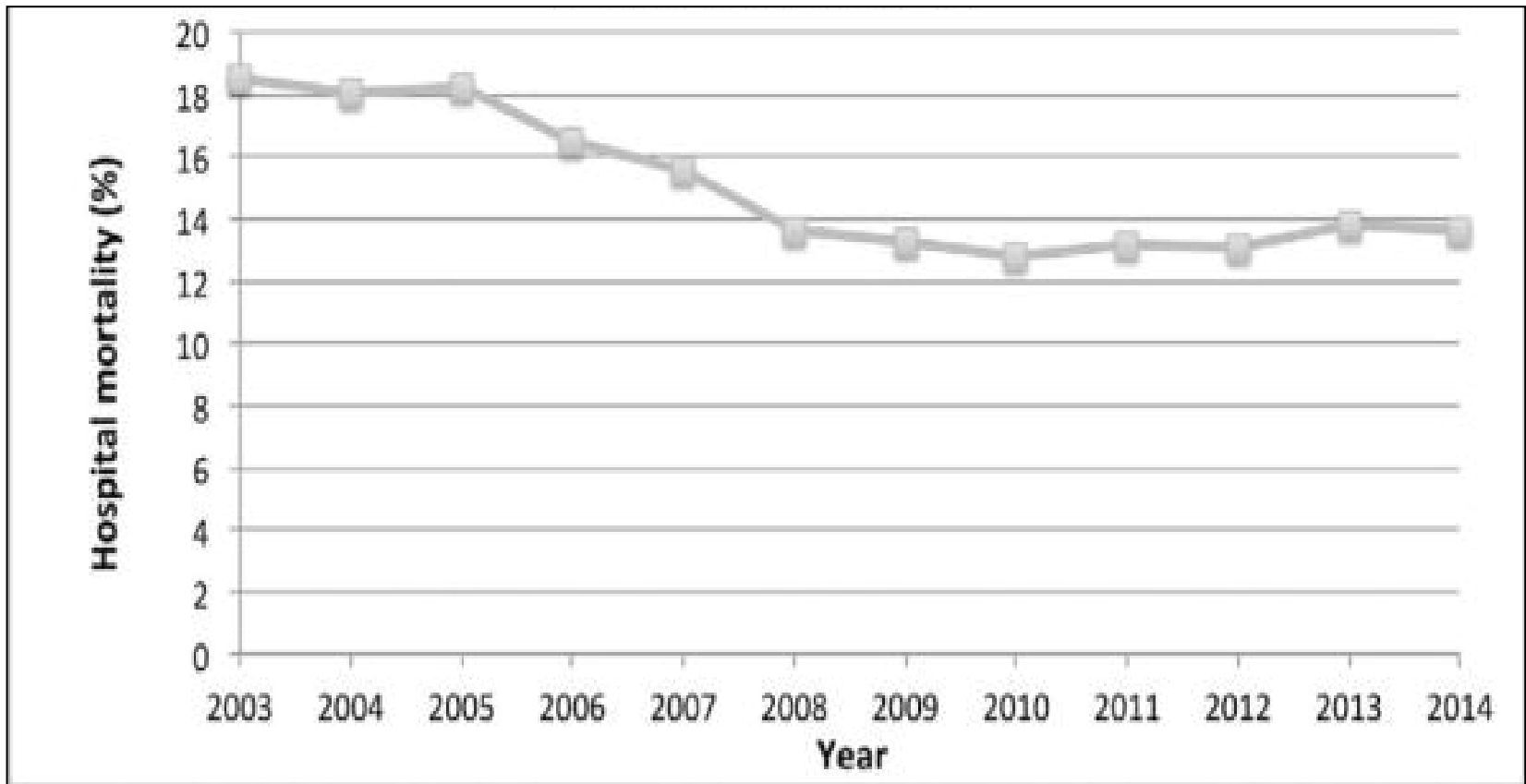
Nursing home



Injury-related mortality 1999-2013

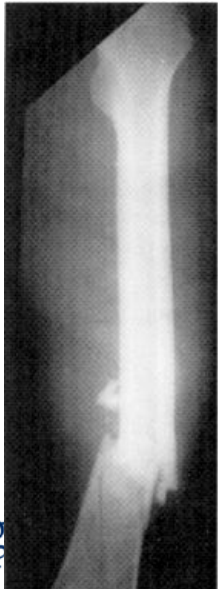
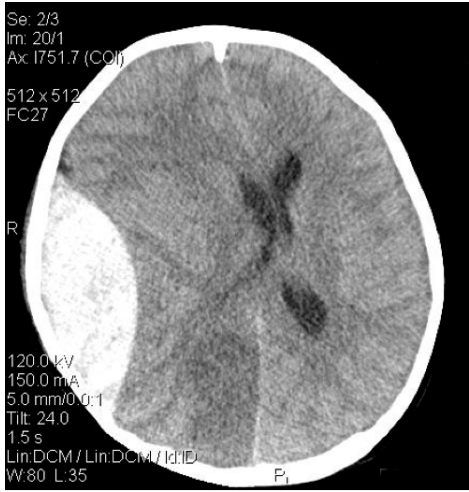


Trauma center mortality 2003-2014



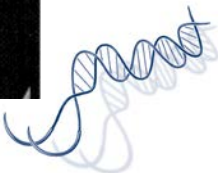
Trauma care – 2017

Focus: restoring anatomy



Trauma care: A success in 2017

“You are lucky to be alive”



Life After Discharge Following Major Injury

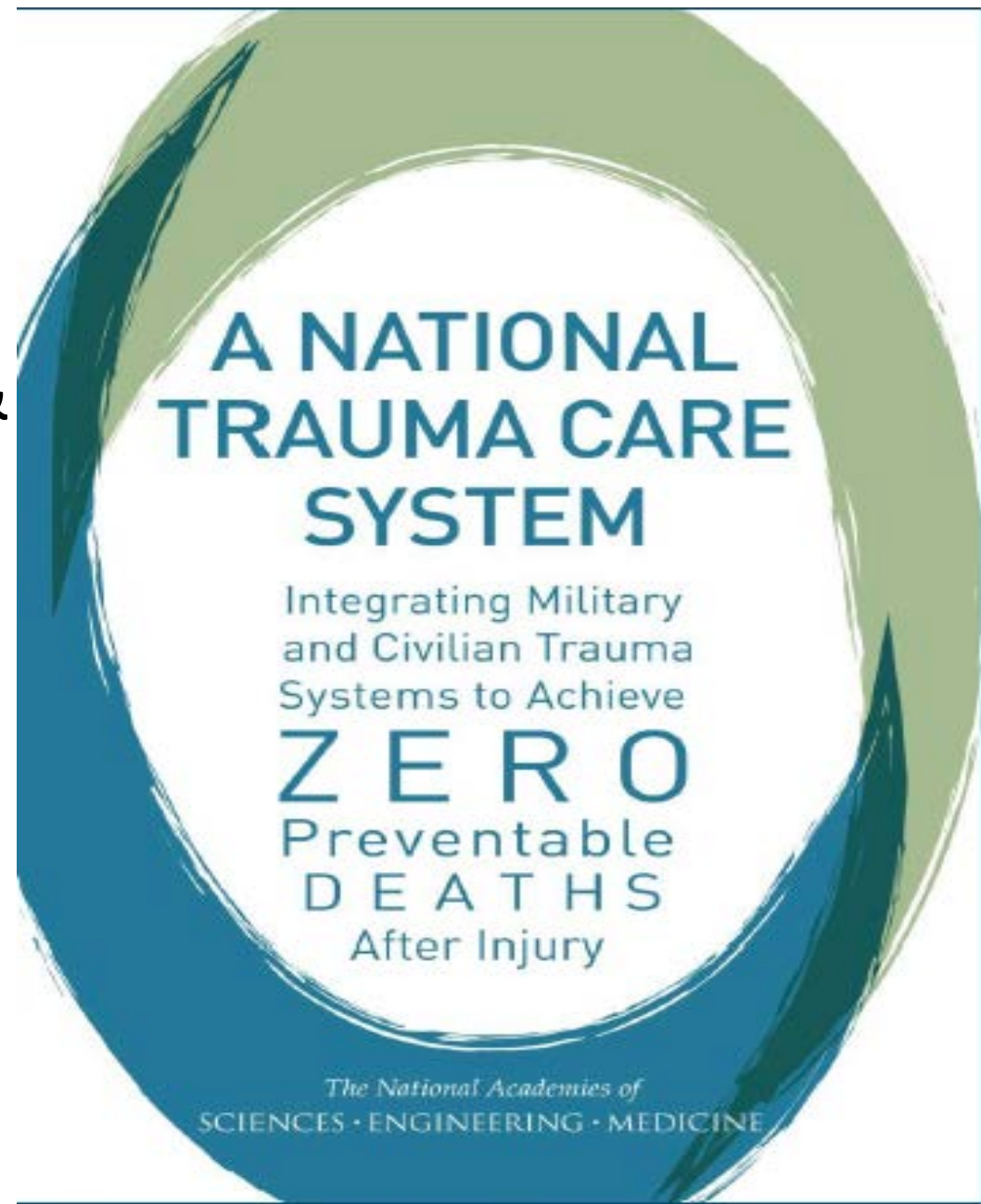
Expanding Our Notion of Quality in Trauma Care

Avery B. Nathens, MD, PhD

Over the past 45 years, there have been significant decreases in injury-related mortality in the developed world.¹ The reduction in the rate of death is multifactorial. For example, road traffic and automotive engineering have reduced pedestrian and motor vehicle crash-related deaths due to a significant focus on primary and secondary prevention. Over the past 15 years, rates of death at the population level have plateaued² (Fig. 1), and to a large degree, will be impacted in the future primarily by legislation related to prevention and or major technological advances related to automotive design and/or improving access to definitive care.



National Academies of
Sciences, Engineering, &
Medicine, June 2016
(aka Institute of Medicine)



Surgery
UNIVERSITY OF TORONTO

RECOMMENDATION 4

The Secretary of Health and Human Services (HHS) should designate and fully support a locus of responsibility and authority within HHS for leading a sustained effort to achieve the national aim of zero preventable deaths after injury and minimizing disability. This leadership role should include coordination with governmental (federal, state, and local), academic, and private-sector partners and should address care from the point of injury to rehabilitation and post-acute care.



Return to Work and Functional Outcomes After Major Trauma

Who Recovers, When, and How Well?

Belinda J. Gabbe, MBiostat, MAppSc, PhD,† Pamela M. Simpson, BSc(Hons), GradDipBiostat,*
James E. Harrison, MBBS, MPH, FAFPHM,‡ Ronan A. Lyons, MB, MPH, MD, FFPHMI, FFPH,*†
Shanthi Ameratunga, MBChB, MPH, PhD,§ Jennie Ponsford, MA, PhD,¶
Mark Fitzgerald, MBBS, MD, FACEM, AFACMA,||** Rodney Judson, MBBS, FRACS, FRCS,††
Alex Collie, PhD,*‡‡ and Peter A. Cameron, MBBS, MD, FACEM*§§*

Ann Surg, 2016

RESEARCH ARTICLE

Long-term health status and trajectories of seriously injured patients: A population-based longitudinal study

Belinda J. Gabbe^{1,2,*}, Pam M. Simpson¹, Peter A. Cameron^{1,3}, Jennie Ponsford^{4,5}, Ronan A. Lyons^{1,2}, Alex Collie^{1,6}, Mark Fitzgerald^{7,8}, Rodney Judson⁹, Warwick J. Teague^{10,11,12}, Sandra Braaf¹, Andrew Nunn¹³, Shanthi Ameratunga¹⁴, James E. Harrison¹⁵

PLOS Medicine, 2017



Surgery
UNIVERSITY OF TORONTO



Return to work

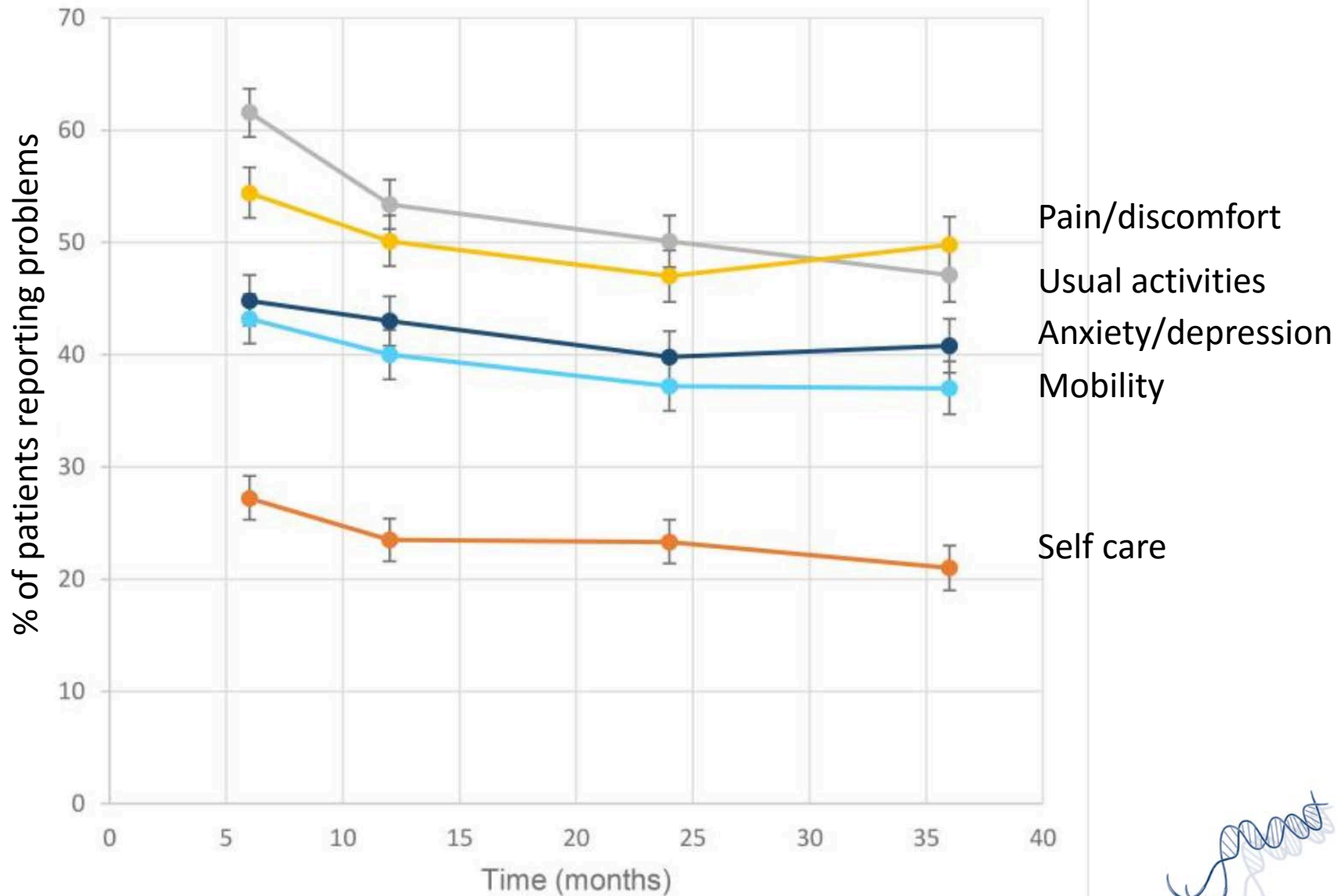
Gabbe, Ann Surg, 2016

- Return to work/study: 58% at 6 months, 66%, 12 months, and 70% at 24 months
- Lower rates of return to work
 - Women
 - Older
 - Pre-existing conditions
 - Lower SES status
 - SCI, TBI
 - Non-managerial/non-professional



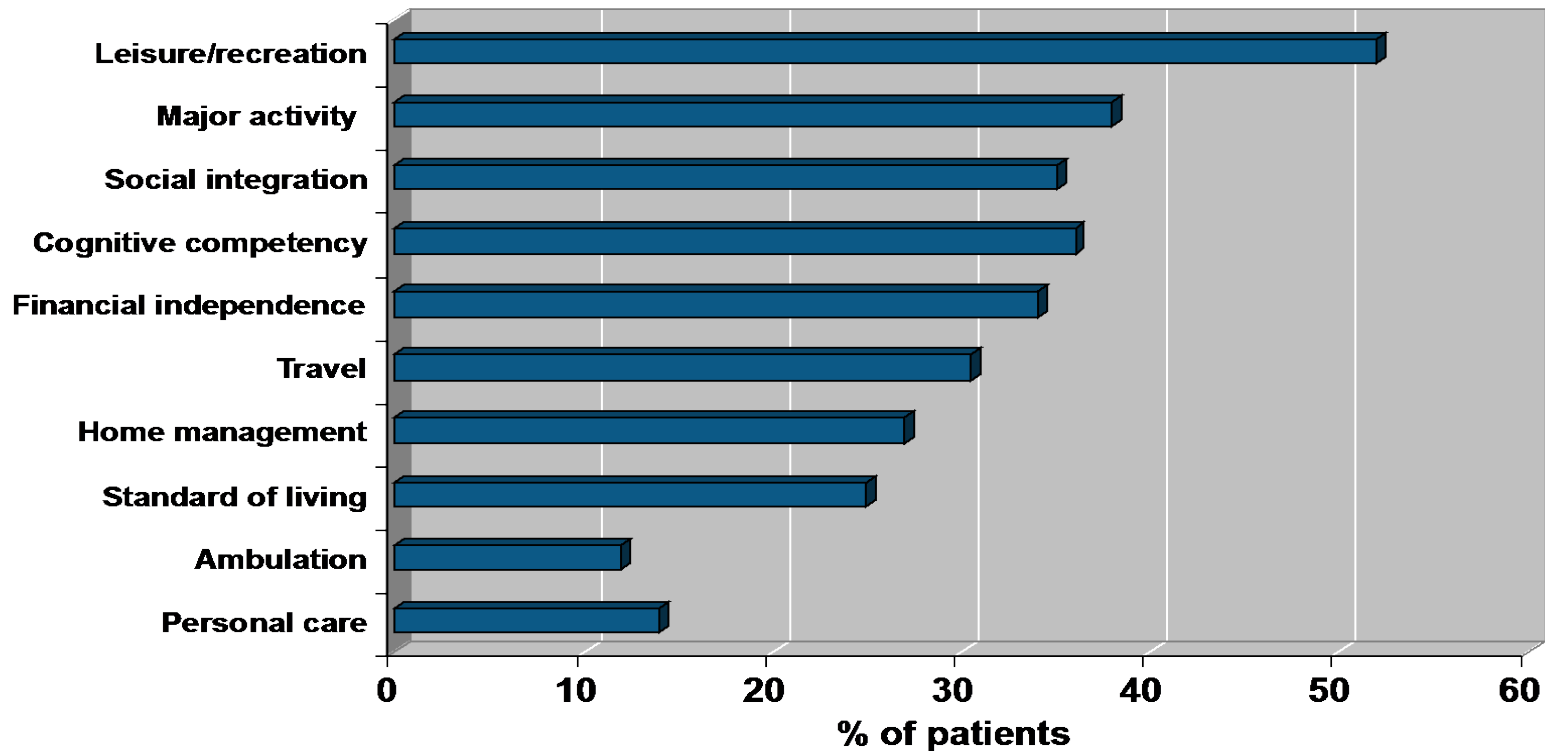
Quality of Life – Major Trauma

EQ-5 @ 3 years



Functional Status in TBI: Partial/complete dependency

Moderate to severe TBI @ 3-5 years



Outcomes following Pelvic Fracture

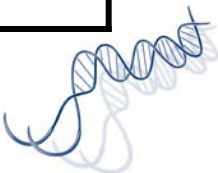
Wright, J Urol 2006

- Pelvic fractures associated with neurovascular and ligamentous injury
 - What is the impact on genitourinary, anorectal and sexual function?
- Prospective cohort study
 - 298 patients with pelvic fracture; 862 without



Adjusted Risk of Male Sexual & Excretory Dysfunction

Fracture configuration	Sexual dysfunction RR (95% CI)	Excretory dysfunction RR (95% CI)
Fracture involving the SI joints	3.6 (1.7-7.8)	2.4 (0.5-12.3)
Open pelvic fracture	2.0 (1.1-3.8)	4.6 (1.7-13)
Symphyseal fracture	1.2 (0.5-2.9)	4.3 (1.1-17)
Closed pelvic fracture	1.7 (0.4-6.9)	3.1 (0.4-23)



Adjusted Risk of Female Sexual & Excretory Dysfunction

	Sexual dysfunction RR (95% CI)	Excretory dysfunction RR (95% CI)
Fracture involving the SI joints	0.6 (0.1-3.4)	1.3 (0.2-6.6)
Open pelvic fracture	0.8 (0.2-2.8)	N/A
Symphyseal fracture	2.4 (0.6-8.7)	6.2 (1.7-22)
Closed pelvic fracture	1.3 (0.3-6.8)	N/A



Reconstruction or amputation of limb threatening injuries?

Bosse, NEJM, 2002

- Prospective cohort study
 - 545 high energy trauma below the femur
 - Baseline, 3, 6, 12, 24 mo assessment
 - 84% f/u at 24 mos



Sickness Impact Profile

- Measure of self reported health status
 - 12 categories of function
 - 2 major dimensions: physical health, psychosocial health
- Score: 0-100
 - Population norms: 2-3
 - Differences of 2-3 are meaningful
 - Severe disability: >10



Outcomes: Reconstruction vs amputation

	12 months		24 months	
	Reconstruct	Amputate	Reconstruct	Amputate
Overall	15	14	12	13
Physical	13	12	10	10
Psychosocial	12	12	10	11
Work (%)	41	42	36	39

No difference in functional outcomes out to 7 years



Factors associated with poor outcome

Bosse, NEJM, 2002

- Low educational level
- Nonwhite
- Poverty
- Lack of private health insurance
- Smoking
- Disability compensation litigation

Focus should be on non clinical interventions and psychosocial/vocational rehabilitation



Perceived/unmet needs in 1st year after injury

Archer, Arch Phys Med Rehab, 2010

- 32% of patients reported having unmet needs
- Highest perceived needs: Home nursing, legal support
- Greatest unmet need: vocational and mental health services
- Primary reason for not obtaining mental health assistance: thought they would get better on their own,
 - For other support services: not knowing where to go



Post-Traumatic Stress Disorder

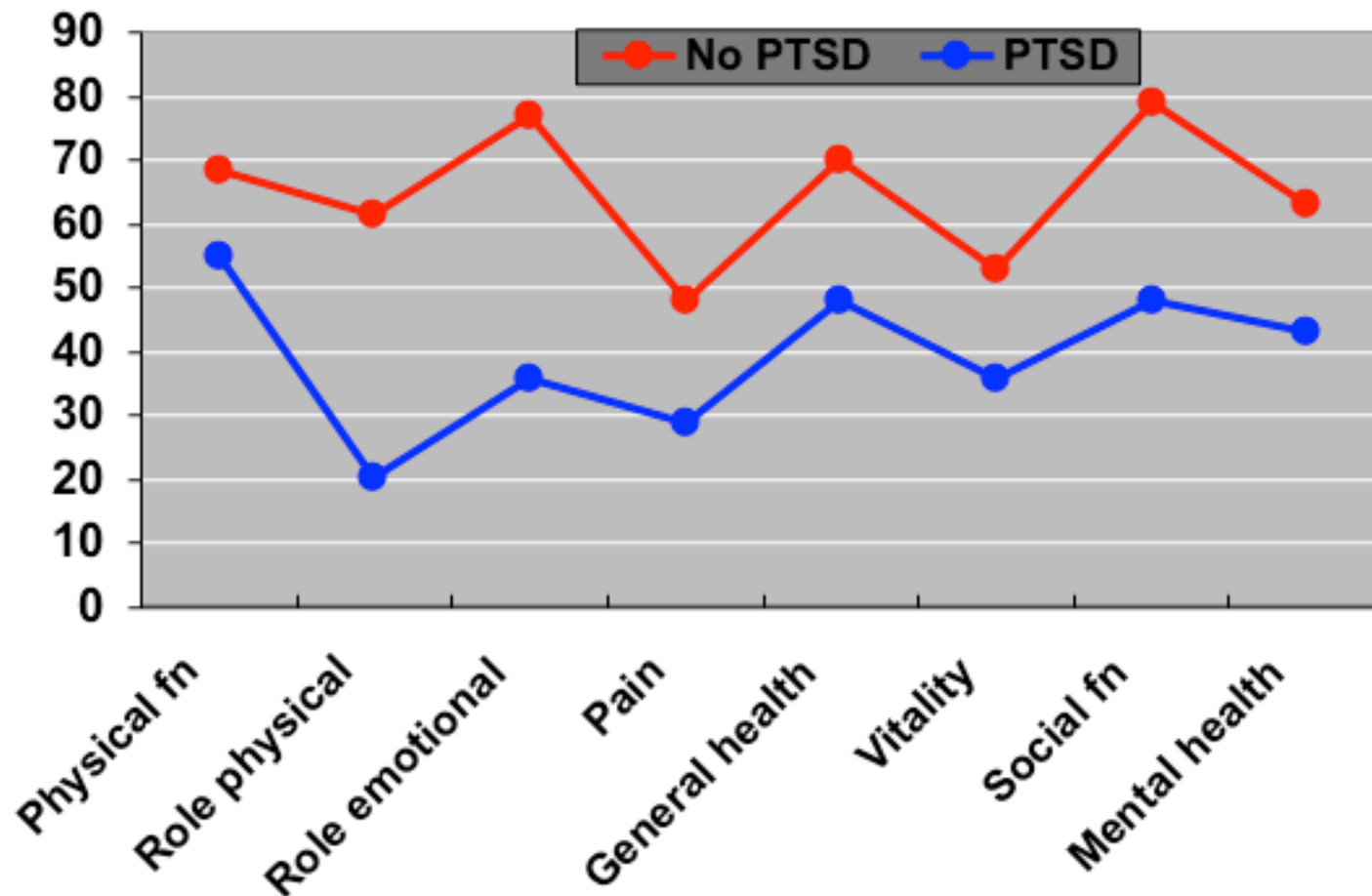
- PTSD symptoms
 - Intrusive, avoidant, arousal
 - 10-40% of all patients admitted following injury
- Predictors
 - PTSD at baseline
 - Prior trauma
 - +ve toxicology screen
 - NOT Injury severity, pre-event functioning/income/education



PTSD & Functional outcomes

Zatzick, Arch Surg, 2002

PTSD : strongest predictor of poor functional outcome



Effectiveness of screening & intervention for PTSD

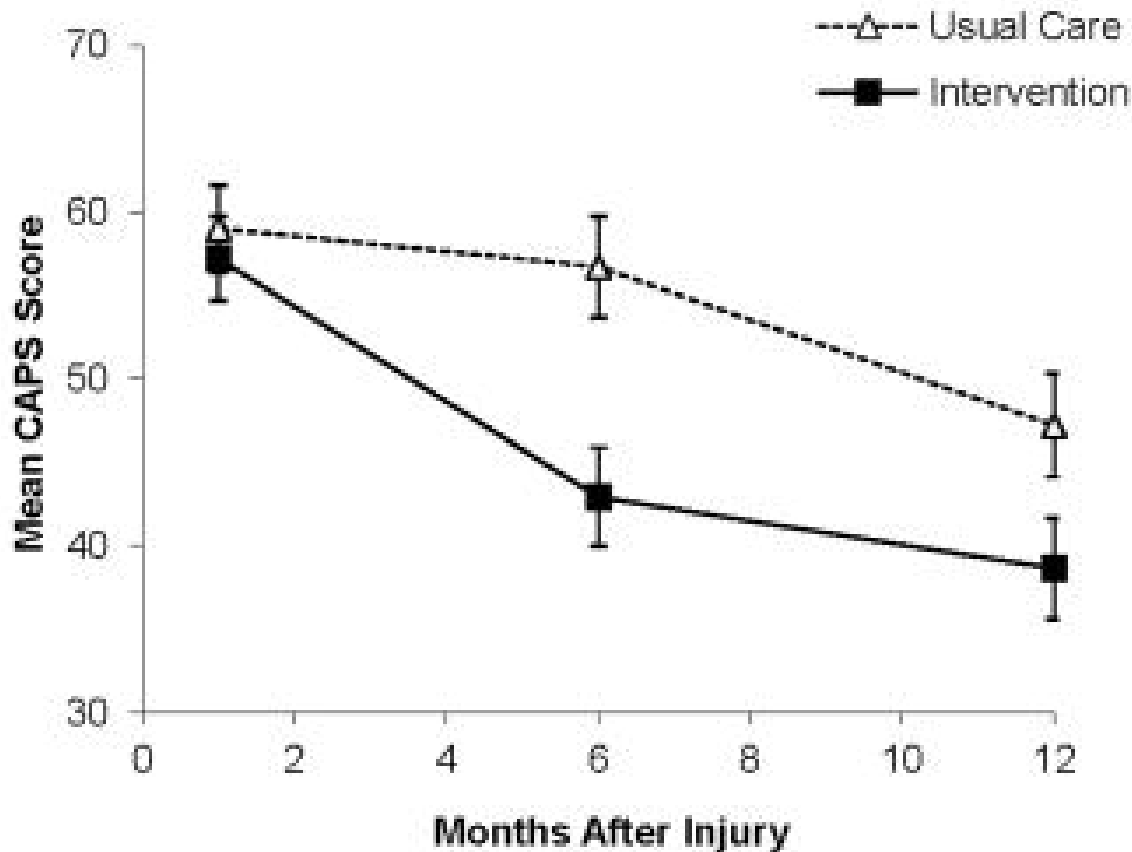
Zatzick, Ann Surg, 2013

- Screened: In-hospital/shortly after discharge
- Stepped interventions
 - Counselling, psychopharmacotherapy, CBT



Effectiveness of screening & intervention for PTSD

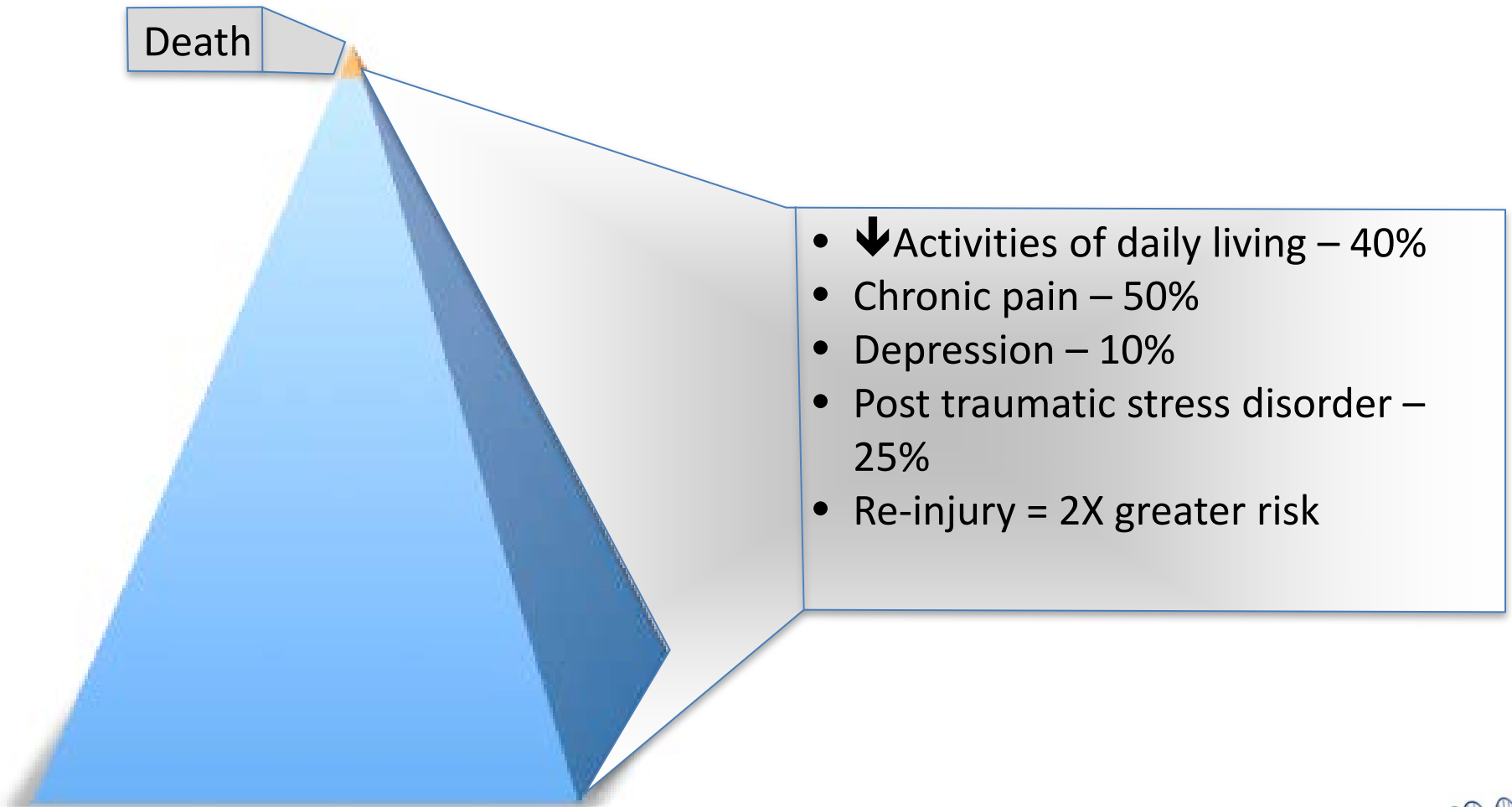
Zatzick, Ann Surg, 2013



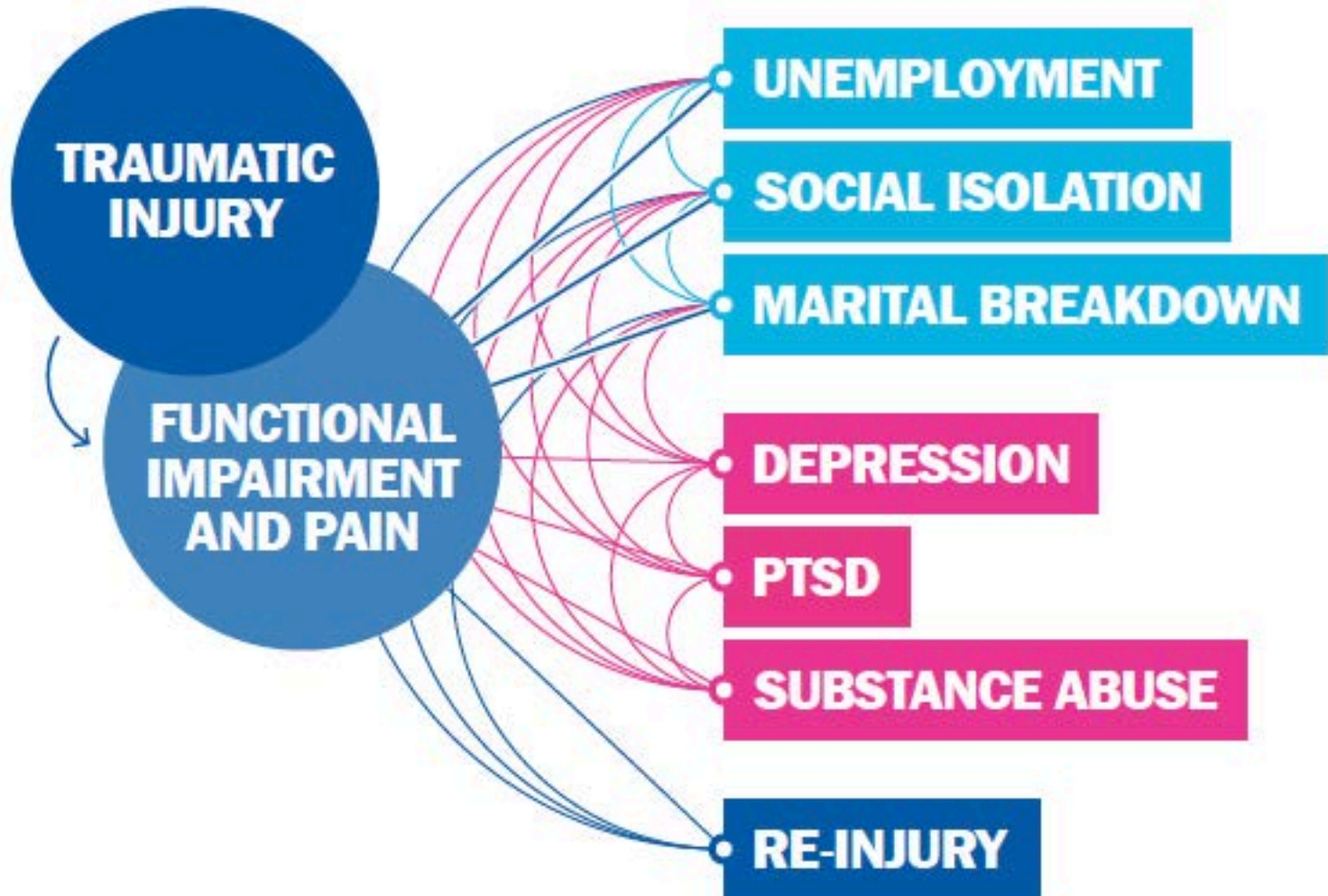
Improvements in physical function, less depression, less alcohol consumption



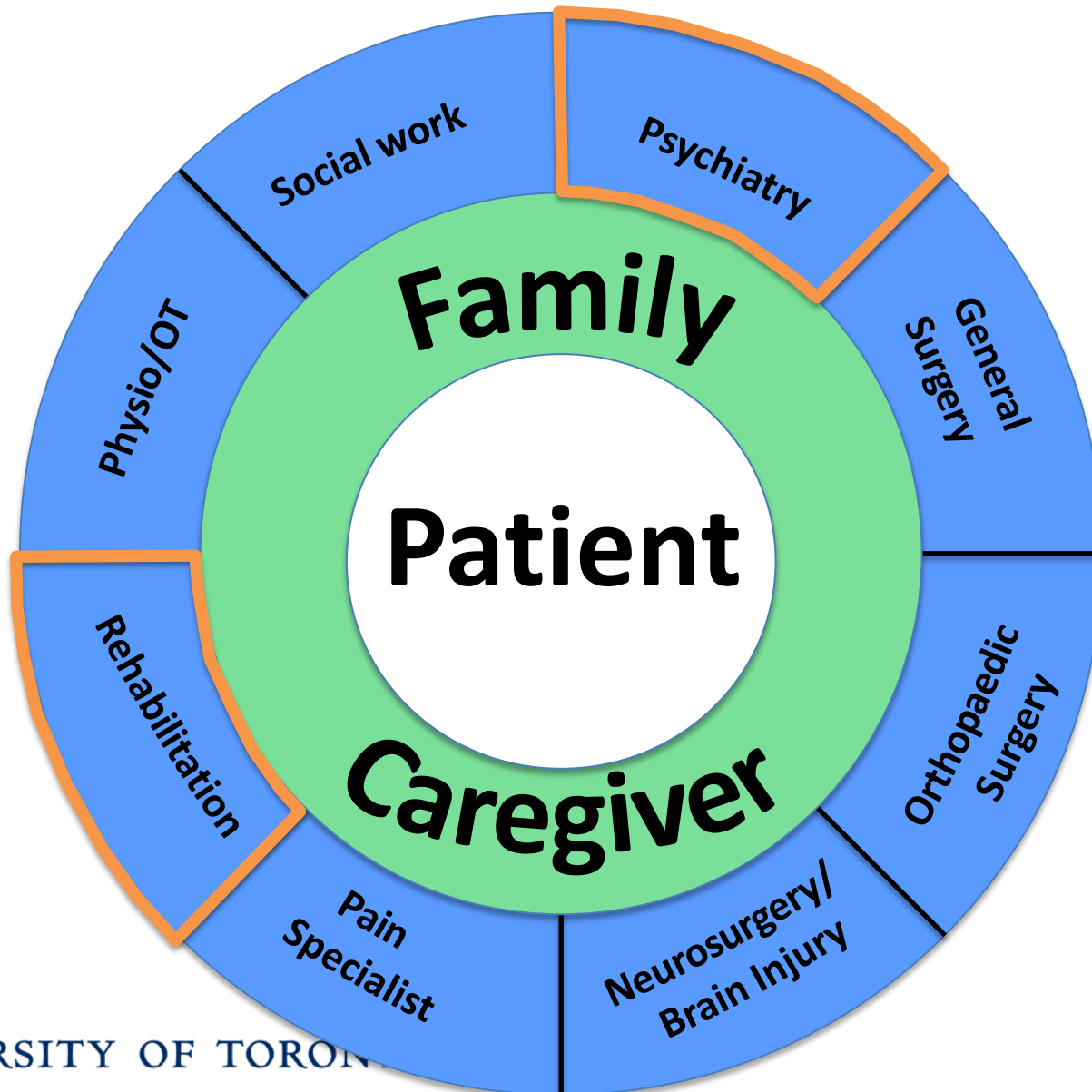
Trauma-related deaths: the tip of the iceberg



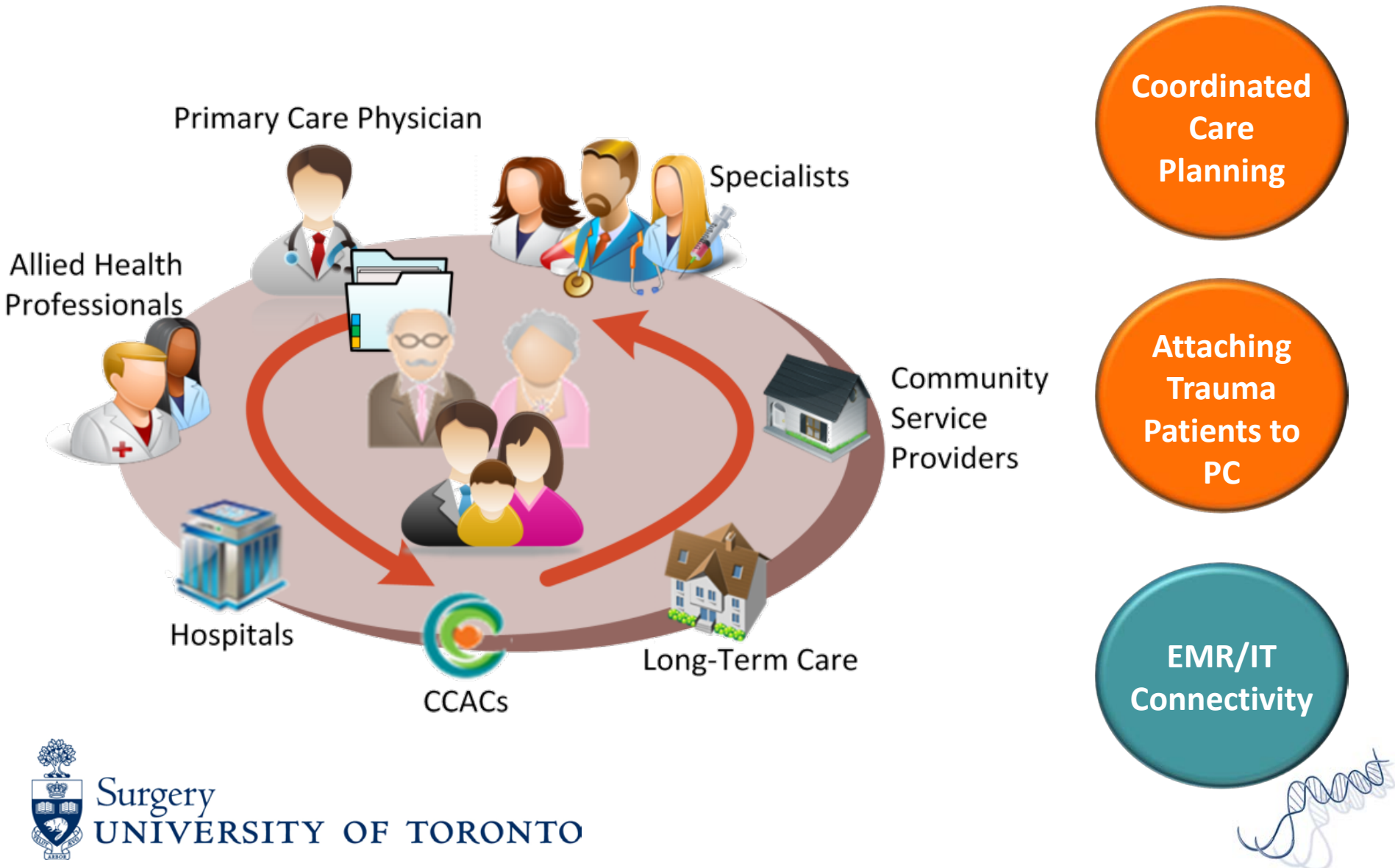
Injury is a complex chronic disease



Multidisciplinary Coordination of Care-Inpatient



Multidisciplinary Coordination of Care Outpatient



Trauma care – 2017

Focus – Survival

Care goal: Restoring anatomy



Trauma care of the future

Focus – Return to productivity,
improving quality of life

Care goal: Restoring function

