
Acute Compartment Syndrome Signs and Symptoms Described in Medical Textbooks

Jeanelle L. Kam, Meituck Hu, Liana L. Peiler, and Loren G. Yamamoto MD, MPH, MBA

Abstract

Objective: To evaluate the accuracy of commonly accessed medical textbooks in their description of the presenting signs/symptoms of acute compartment syndrome (ACS).

Methods: Textbooks in six different specialties were surveyed for information about ACS. Informational content was scored using a 0 to 4 point system.

Results: 67 textbooks (36 primary care, 31 specialty) were reviewed. Of the 36 primary care textbooks evaluated, 29 contained no information on ACS. Three of the remaining 7 primary care books provided inaccurate information (43%). Only 3 of the 31 specialty books scored 0. Four of the remaining 28 specialty books provided inaccurate information (14%). Overall, 23 of the 31 specialty books (74%) provided accurate information (score of 3 or 4), compared to only 2 of the 36 primary care books (6%) ($p < 0.001$).

Conclusions: Some textbooks contain inaccurate information in the diagnosis of acute compartment syndrome, which may delay the diagnosis resulting in irreversible morbidity. In reality, there are only three P's (pain, paresthesia, paresis) which are important.

Introduction

Acute compartment syndrome occurs whenever increased tissue pressure in an osteofascial compartment compromises blood flow to muscles and nerves within the compartment, resulting in tissue damage.¹ The elevated compartment pressure, due to various origins such as hemorrhages, fractures, crush injuries, muscle edema and limb casts, leads to blockage of venous outflow^{1,2} and subsequent venous infarction. As the pressure within a compartment exceeds the venous outflow pressure, venous outflow ceases. Without venous outflow, net capillary flow ceases leading to ischemia and subsequent infarction. Intracompartmental infarction results in death of neural tissue as well as rhabdomyolysis. Disability resulting from amputation or permanent limb dysfunction, may result if treatment is not initiated in time.

Because of the seriousness of this condition, prompt diagnosis is essential. It is common practice for compartment syndrome to be described by medical reference texts and resource materials as the 5 P's, sometimes 6 P's (Pain, Pallor, Pulselessness, Paresthesia, Paresis, Poikilothermia). In actuality, pulselessness and pallor are NOT presenting symptoms. These would be regarded as late find-

ings (actually too late), indicating a poor prognosis. Pulselessness and pallor are acute signs of arterial embolization, rather than what occurs in an acute compartment syndrome (which is a venous outflow obstruction). Pallor is not usually seen initially due to continuous cutaneous perfusion originated from sources proximal to or outside the involved compartment. Pulselessness is an extremely late finding and is rare upon initial presentation. Arterial pulsation will still occur even if no forward flow occurs, making this a deceiving and dangerous phenomenon, because a clinician may fail to consider the possibility of a compartment syndrome just because pulsation is present.² In fact, some textbooks have specifically listed "Pulsation Present" instead of "Pulselessness" as one of the P's to emphasize this point and counter the misinformation that has been published in the past. Poikilothermia, which probably refers to the coolness of an extremity, is similarly a late sign of compartment syndrome.

Therefore, pallor and pulselessness are not considered reliable criteria for the diagnosis of acute compartment syndrome. Excruciating pain with increasing severity in conjunction with numbness/paresthesia and paresis are highly suspicious for an acute compartment syndrome. It is critical to recognize, diagnose, and treat acute compartment syndrome in a timely manner. Therefore it is crucial that medical references accessed by physicians, physicians-in-training, and other medical personnel are accurate in their description of acute compartment syndrome. Promoting the 5 or 6 P's suggesting that pallor and pulselessness are signs/symptoms of acute compartment syndrome may contribute to a delay in diagnosis and treatment.

The purpose of this study is to evaluate the accuracy of commonly accessed medical textbooks in their description of the presenting signs/symptoms of acute compartment syndrome.

Methods

A review of medical textbooks was conducted at the Hawaii Medical Library using texts from both the reference and shelved section. Reference texts were exhausted first to ensure that all standard books were covered in our study. Each textbook (which had information on compartment syndrome) was reviewed by a team of three reviewers and assigned a score based on consensus.

Texts that provided no information on acute compartment syndrome were scored as a zero. A score of 1 was assigned if the book indicated that pallor or pulselessness are signs/symptoms of acute compartment syndrome. A score of 2 was assigned if only brief information about acute compartment syndrome was supplied, but

Correspondence to:
Loren G. Yamamoto, MD, MPH, MBA
Professor of Pediatrics
1319 Punahou Street, #733
Honolulu, HI 96826
Phone: (808)983-8387
Fax: (808)945-1570
E-mail: Loreny@hawaii.edu

Table 1.—Incidence of textbook scores in various medical disciplines, N=67

Score	Ped	FP	IM	CC	EM	Ortho	Surg
(n)	(10)	(11)	(15)	(5)	(11*)	(10)	(5)
0	9	8	12	1	2	0	0
1	0	0	3	0	3	1	0
2	0	2	0	1	2	0	0
3	1	0	0	0	4	4	2
4	0	1	0	3	2	5	3

*Two books described compartment syndrome in two separate chapters, which resulted in contradictory scores.

there was no information suggesting that pallor and pulselessness are signs/symptoms of acute compartment syndrome. A score of 3 was assigned if the text provided accurate information on signs and symptoms (i.e., that pallor and pulselessness are only late signs of acute compartment syndrome). A score of 4 was assigned if the text provided the correct information just as in the score of 3, but additionally, the text described a method to measure intracompartmental pressure. The categories can be summarized below:

- 0 = Compartment syndrome not covered.
- 1 = Incorrect information present.
- 2 = Minimal information present, but nothing which is incorrect.
- 3 = Correct information present.
- 4 = Correct information, plus instructions on how to measure the intracompartmental pressure is sufficiently described.

The content reviewed was focused on acute compartment syndrome. We did not consider chronic compartment syndrome, exercise induced compartment syndrome or abdominal compartment syndrome.

Results

We evaluated a total of 67 textbooks (see reference list) for the content and accuracy of their descriptions of acute compartment syndrome. This included 36 primary care textbooks (from pediatrics, family practice, and internal medicine) and 31 specialty references (from critical care, emergency medicine, orthopedics, and general surgery). Textbooks that earned a score of 0 were eliminated from the mean calculation.

Textbook scores are stratified by the specialty areas in table 1. Of the 36 primary care textbooks evaluated, 29 scored 0 (contained no information). Three of the remaining 7 primary care books had a score of 1 (50%, all from internal medicine). Only 3 of the 31 specialty books scored 0. Four of the remaining 28 specialty books had a score of 1 (14%) ($p=0.05$, Chi-square testing comparing the rate for primary care versus subspecialty textbooks)

Overall, 23 of the 31 specialty books (74%) scored well (3 or 4), compared to only 2 of the 36 primary care books (6%) which scored well (3 or 4) ($p<0.001$).

Discussion

The number of textbooks that incorrectly list pallor and pulselessness as signs/symptoms of acute compartment syndrome is smaller than we expected, but such textbooks with incorrect informational content on this topic, still exist. However, if a primary care physician decides to learn about acute compartment syndrome in a primary care textbook, they are not likely to find any information. Specialty textbooks are more likely to have useful information that is correct.

Mnemonics are commonly used in the education process to facilitate learning. However, in this case, the desire to add more P's (to augment the mnemonic), has resulted in an educational disservice to physicians who have learned the 5 or 6 P's. It is difficult to undo this, but future book editors and authors should be careful to avoid this pitfall. In reality, there are only three P's (pain, paresthesia, paresis) that are important. The other P's are too late.

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Pediatrics books

- P1. Behrman R, Kliegman R, Jenson H (eds). *Nelson Textbook of Pediatrics*. 16th edition. 2000. Philadelphia: W.B. Saunders, pp. 2110-2112.
- P2. Bernstein D, Shelov SP (eds). *Pediatrics*. 1996. Baltimore: Williams and Wilkins.
- P3. Finberg L (ed). *Saunders' Manual of Pediatric Practice*. 1998. Philadelphia: W.B. Saunders.
- P4. Fox JA (ed). *Primary Health Care of Children*. 1997. St. Louis: Mosby.
- P5. Hay WW, et al (eds). *Current Pediatric Diagnosis and Treatment*. 15th edition. 2001. New York: McGraw Hill.
- P6. Markel H, Farrell MH, Oski JA (eds). *The Portable Pediatrician*. 2nd edition. 2000. Philadelphia: Hanley and Belfus.
- P7. Sponseller PD. Bone and Joint Disorders. In: McMillan JA, et al (eds). *Oski's Pediatric Principles and Practice*. 3rd edition. 1999. Philadelphia: Lippincott, Williams and Wilkins, pp. 2102-2133.
- P8. Schwartz MW (ed). *The 5 Minute Pediatric Consult*. (2nd edition), 2000. Philadelphia: Lippincott, Williams & Wilkins.
- P9. Sponseller PD, Stevens HM (eds). *Handbook of Pediatric Orthopaedics*. 1996. Philadelphia: Lippincott, Williams and Wilkins.
- P10. Waterson T., Helms P., Platt MW (eds). *Paediatrics: Understanding Child Health*. 1997. Oxford: Oxford University Press.

Family Practice books

- FP1. Brier SR. *Primary Care Orthopaedics*. 1999. St. Louis: Mosby.
- FP2. Driscoll C E, et al (eds). *The Family Practice Desk Reference*. 3rd edition. 1996. St. Louis: Mosby.
- FP3. Graber MA. *Emergency Medicine*. In: Graber MA, Toth PP, Hering RL (eds). *University of Iowa: The Family Practice Handbook*. 3rd edition. 1997. St. Louis: Mosby, pp. 1-73.
- FP4. Marshall KG (ed). *Family Practice Sourcebook*. 1999. St. Louis: Mosby.
- FP5. Murtagh J (ed). *General Practice*. 2nd edition. 1998. Sydney: The McGraw-Hill Companies.
- FP6. Jardon OM, Mathews MS. *Orthopedics*. Rakel RE (ed). *Textbook of Family Medicine*. 5th edition. 1995. Philadelphia: W.B. Saunders Company, pp. 917-1005.

- FP7. Rakel RR (ed). Essentials of Family Practice, 2nd edition, 1998. Philadelphia: W.B. Saunders.
 FP8. Saulitz JW (ed). Textbook of Family Medicine, 2000. New York: McGraw-Hill.
 FP9. Schaffer TC, Hoffman DF. Overuse Injuries. In: Taylor RB (ed). Manual of Family Practice, 1997. Boston: Little, Brown and Company, pp. 551-557.
 FP10. Taylor RB (ed). Family Medicine: Principles & Practice, 5th edition, 1998. New York: Springer.
 FP11. Taylor RB (ed). Fundamentals of Family Medicine: The Family Medicine Clerkship Textbook, 2nd edition, 1999. New York: Springer.

Internal Medicine books

- IM1. Beers MH, et al (eds). The Merck Manual of Diagnosis & Therapy, 17th edition, 1999. Whitehouse Station: Merck Research Laboratories.
 IM2. Fauci AS, et al (eds). Harrison's Principles of Internal Medicine, 15th edition, 2001. New York, McGraw-Hill.
 IM3. Carey CF, Lee HH, Woeltje KF (eds). The Washington Manual of Medical Therapeutics, 29th edition, 1998. Philadelphia: Lippincott-Raven.
 IM4. Dambro MR (ed). Griffith's 5-Minute Clinical Consult, 2000. Philadelphia: Lippincott-Williams and Wilkins.
 IM5. Edwards CRW, et al (eds). Davidson's Principles and Practice of Medicine, 17th edition, 1995. New York: Churchill Livingstone.
 IM6. Fishman MC, et al (eds). Medicine, 4th edition, 1996. Philadelphia: Lippincott-Raven.
 IM7. Goodwin CW. Electrical Injury. In: Goldman L, Bennett JC (eds). Cecil: Textbook of Medicine, 21st edition, 2000. Philadelphia: W.B. Saunders Company, p. 68-70.
 IM8. Kassir JP, Greene HL (eds). Current Therapy in Adult Medicine, 4th edition, 1997. St. Louis: Mosby.
 IM9. Katty K, et al (eds). Kochar's Concise Textbook of Medicine, 3rd edition, 1998. Baltimore: Williams and Wilkins.
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 IM13. Victoroff BN. Evaluation of Acute Sports Injuries of the Adult. In: Rippe JM (ed). Lifestyle Medicine, 1999. Malden: Blackwell Science, Inc., pp. 242-258.
 IM14. Stein JH (ed). Internal Medicine, 5th edition, 1998. St. Louis: Mosby.
 IM15. Stobo JD, et al (eds). The Principles and Practice of Medicine, 23rd edition, 1996. Stamford: Appleton and Lange.

Critical Care books

- CC1. Schmalzried TP, Guttman D. Critical Care of the Orthopedic Patient. In: Bongard FS, Sue DY (eds). Current Critical Care Diagnosis & Treatment, 1994. Norwalk, CT: Appleton & Lange, pp. 731-740.
 CC2. Freedman JI, Enneking FK. Orthopedic Complications. In: Civetta JM, Taylor RW, Kirby RR. Critical Care, 3rd edition, 1997. Philadelphia: Lippincott-Raven Publishers, pp. 1231-1252.
 CC3. Rohrer MJ. Compartment Syndromes. In: Irwin RS, Cerra FB, Rippe JM (eds). Irwin and Rippe's Intensive Care Medicine, 4th edition, 1999. Philadelphia: Lippincott-Raven Publishers, pp. 2058-2065.
 CC4. Thangathurai D, Mikhail MS. Anesthesia for High-Risk Patients. In: Grenvik A, Ayres SM, Holbrook PR, Shoemaker WC (eds). Textbook of Critical Care, 4th edition, 2000. Philadelphia: W.B. Saunders, pp. 283-289.
 CC5. Murray MJ, et al (eds). Critical Care Medicine: Perioperative Management, 1997. Philadelphia: Lippincott-Raven.

Emergency Medicine books

- EM1. Williams KA, et al. Emergency Medical Services/Disaster Medicine. In: Aghdabian RV, et al (eds). Emergency Medicine: The Core Curriculum, 1998. Philadelphia: Lippincott-Raven, pp. 1341-1397.
 EM2. Barkin RH, Rosen P (eds). Emergency Pediatrics: A Guide to Ambulatory Care, 5th edition, 1999. St. Louis: Mosby.
 EM3. Go, S. Extremity Pain and Numbness. In: Davis MA, Greenough G, Votey S (eds). Signs and Symptoms in Emergency Medicine: Literature Based approach to Emergency Conditions, 1999. St. Louis: Mosby, pp. 114-122.
 EM4A. Bachman D, Santora S. Orthopedic Trauma. In: Fleischer GR, Ludwig S, Silverman BK (eds). Synopsis of Pediatric Emergency Medicine, 1996. Baltimore: Williams and Wilkins, pp. 674-691.
 EM4B. Sherk H, Black J. Orthopedic Emergencies. In: Fleischer GR, Ludwig S, Silverman BK (eds). Synopsis of Pediatric Emergency Medicine, 1996. Baltimore: Williams and Wilkins, pp. 755-759.
 EM5A. Sinert R. Rhadomyolysis. In: Howell JM, et al (eds). Emergency Medicine, Vol. 2., 1998. Philadelphia: W.B. Saunders, pp. 1255-1260.
 EM5B. Veenema KR. Elbow and Forearm Injuries. In: Howell JM, et al (eds). Emergency Medicine, Vol. 2., 1998. Philadelphia: W.B. Saunders, pp. 1152-1171.
 EM6. Stack LB. Compartment Syndrome Evaluation. In: Roberts JR, Hedges JR (eds). Clinical Procedures in Emergency Medicine, 3rd edition, 1998. Philadelphia: W. B. Saunders Company, pp. 932-946.
 EM7A. Giederman JM. Orthopedic Injuries: Management Principles. In: Rosen P, et al (eds). Emergency Medicine: Concepts and Clinical Practice, 4th edition, Vol. 1, 1998. St. Louis: Mosby, pp. 602-624.
 EM7B. Salluzzo RF. Rhadomyolysis. In: Rosen P, et al (eds). Emergency Medicine: Concepts and Clinical Practice, 4th edition, Vol. 3, 1998. St. Louis: Mosby, pp. 2478-2487.
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Orthopedics books

- O1. Beatty JH, et al (eds). Orthopaedic Knowledge Update, 1999. Rosemont: American Academy of Orthopaedic Surgeons, pp. 521-532.
 O2. Brinker MR, Miller MD (eds). Fundamentals of Orthopaedics, 1999. Philadelphia: W.B. Saunders Company.
 O3A. Cooper RR. Fractures in Children. In: Clark CR, Bonfiglio M. Orthopaedics: Essentials of Diagnosis and Treatment, 1994. New York: Churchill Livingstone, pp.215-234.
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