Western Carolina University

Undergraduate Research Grant

Medication Calculation Skills of Paramedics

December 9, 1997

Applicants: Kyle Paschal, Department of Health Sciences
Lori Robison, Department of Health Sciences
Alan Sanders, Department of Health Sciences

Faculty Mentor: Dr. Michael W. Hubble, Department of Health Sciences

Other investigations report similarly alarming results. Bayne and Bindler examined the drug calculation skills of 62 nurses and found that only 35 percent of these nurses could achieve a score of 90 percent or better on a 20-item medication exam.[9] Only 75 percent of the nurses scored 70 percent or better on the exam. Conti and Beare administered a drug calculation test to 55 newly hired nurses as part of their new employee orientation program.[1] Only 38 nurses (69.1%) were able to score 90 percent or better on the exam. In their investigation, there was no significant differences in test scores based on length of nursing experience. However, test scores were significantly higher for nurses prepared at the associate or baccalaureate level than for diploma nursing graduates, suggesting that educational differences may contribute to errors in medication calculations.

Despite the alarming rate of medication dosage calculation errors among nurses and physicians, no examination of such risks has been performed for patients treated by paramedics in the prehospital setting. In a national survey of EMS providers, Lavery et al identified over 80 different medications on the drug formularies of survey respondents.[10] Given the sizable drug formulary of EMS providers in the U.S., coupled with the significant incidence of medication errors in the hospital setting, it is plausible that there is considerable potential for adverse medication dosing errors among patients treated by paramedics. This investigation will be the first of its kind to assess the potential hazards of medication calculation skills of paramedics.

Project Plan

A demographic questionnaire and a 10- item medication calculation test will be administered to a convenience sample of paramedics (Appendix 1). The exam will be administered during regularly scheduled staff meetings or continuing education sessions of 10 North Carolina EMS agencies during the months of January and February, 1998 (Table 1). The EMS agencies were selected such that they represent a cross-section of EMS systems across the state in terms of organizational structure, call volumes, shift schedules, and paramedic work experience. Variables of interest include paramedic work experience and education, call volume, frequency of medication administration, self assessment of drug calculation skills and anxiety associated with medication calculations, use of drug calculation aids, error rates on calculation test, and types of errors committed on the calculation test.

Table 1. Profile of participating EMS agencies.

EMS System	Estimated Monthly Call Volume	Number of Paramedics Employed Full-time	Average Number of Calls per Paramedic per Month	Estimated Percentage of Calls in which Medications are Administered	Estimated Sample Size (80% of Work Force)
Caswell County EMS	230	6	38.33	20.00%	5
Chatham County EMS	700	18	38.89	25.00%	14
Garner Rescue	150	9	16.67	20.00%	7
Haywood County EMS	700	30	23.33	20.00%	24
Henderson County EMS	800	20	40.00	20.00%	16
Jackson County EMS	230	15	15.33	20.00%	12
Mecklenburg County EMS	4500	100	45.00	20.00%	80
Montgomery County EMS	250	19	13.16	30.00%	15
Randolph County EMS	830	26	31.92	27.00%	21
TOTAL SAMPLE					195

Frequency tables will be developed to provide a descriptive profile of the educational levels, call volumes, work experience, frequency of medication administration, use of drug calculation aids, and self-assessment of calculation skills and anxiety associated with drug calculations. Where appropriate, descriptive statistics will be used to further describe the demographic variables. Associations between self-rated calculation skills and education level, and calculation anxiety and education level, will be examined using the chi square test for independence (objective 1). Associations between self-rated calculation skills and work experience, and calculation anxiety and work experience, will be measured by analysis of variance (ANOVA) techniques. The relationships between the use of calculation aids and education level, work experience, and call volume will be examined using the chi square test for independence (objective 2).

Following administration of the calculation tests, each test will be scored independently by 4 separate graders. Each question will be graded on three different criteria:

1. The nominal scale of correct/incorrect.
2. The percentage of error from the correct answer (percentage of underdosage or overdosage).
3. Type of error based on the following categories:
    a. Conceptual error (error in problem set-up or formula use).
    b. Error in weight conversions (example: pounds to kilograms).
    c. Error in drug unit conversion (example: milligrams to micrograms).
    d. Mathematical error.

Inter-rater reliability of the graders will be analyzed using the odd-even split half reliability test.

From the examination results, the percentage of paramedics lacking the skill to complete the exam with 90% accuracy can be determined (objective 3). Associations between test scores and work experience, and test scores and call volume, will be analyzed using ANOVA techniques (objective 4). Differences in test scores based upon educational level and frequency of medication administration will be analyzed using the chi square test of independence (objective 4). Associations between the types of errors and educational level, frequency of medication administration, work experience, and call volume will also be analyzed using the chi square test of independence (objective 5). Associations between error rates and self-assessed level of calculation skills will be examined using chi square techniques, as will the association between self-assessed anxiety levels and error rates (objective 6).

Project Timeline

January - February	Data collection
March	Data entry
April	Data analysis
May	Manuscript preparation
July	Presentation of results at the National Association of EMS Physicians Scientific Assembly

Budget and Budget Justification

Funding is requested for printing of data collection instruments. These instruments will be distributed to each of the participating EMS agencies for use during their next regularly scheduled staff meeting or continuing education program.

Travel is necessary for the investigators to attend the staff meeting of each of the EMS agencies during which the calculation exam is administered. A total of 10 trips totaling 900 miles is anticipated.

Calculators are necessary to complete the examination and to request the paramedics to bring their own calculators to the meeting would provide clues that a drug calculation exam is likely. This would likely encourage the test subjects to review drug dosage calculations prior to completing the examination, introducing bias into the results. Therefore, funding is requested to purchase calculators for use during each examination administration. After completion of the project, the calculators would remain in the Health Sciences Department where they would be used during classroom exercises and exams on drug calculations.

Table 2. Budget

Travel (900 miles @ $0.21)	$189.00
Calculators (30 @ $4.25)	$127.50
Printing (800 @ $0.10)	$80.00
TOTAL	**$396.50**

Bibliography

1. Conti A, Beare P: Performance on a Mathematics/Drub Calculation Test: Relationship to Subsequent Reported Medication Errors. Journal of Nursing Staff Development 1988; Spring, 54-58.
2. Brown G: Medication Errors: A case study. Hospitals 1979; 53: 61-65.
3. Poster E, Pelletier, L: Primary versus Functional Medication Administration: Monitoring and Evaluating Medication Error Rates. Journal of Nursing Quality Assurance 1988; 2:68-76.
4. Worrell P, Hodson K: Posology: The Battle Against Dosage Calculation Errors. Nurse Educator 1989; 14: 27-31.
5. Davis N, Cohen M: Medication Errors: Causes and Prevention. Philadelphia: George F. Stickley, 1981.
6. Cohen M: Are Errors Waiting to Happen? Nursing 88 1988; 18:18.
7. Koska M: Drug Errors: Dangerous, Costly, and Avoidable. Hospitals 1989; 63: 24.
8. Perlstein P, Callison C, White M, Barnes B, Edwards N: Errors in Drug Computations During Newborn Intensive Care. American Journal of Diseases of Children 1979; 133:376-379.
9. Bayne T, Bindler R: Medication Calculation Skills of Registered Nurses. The Journal of Continuing Education in Nursing 1988; 19(6): 258-262.
10. Lavery R, Doran J, Tortella B, Cody R: A Survey of Advanced Life Support Practices in the United States. Prehospital and Disaster Medicine 1992; 7:144-150.

APPENDIX 1

Survey Instrument

Medication Calculation Skills of Paramedics

This survey is being conducted as part of a class research project at Western Carolina University. The purpose of the project is to assess the medication calculation skills of practicing paramedics. This brief survey is being conducted to determine **your** skills in calculating drug dosages. Questions on the survey include a limited number of personal information items and drug calculation problems that you are likely to encounter in the routine performance of your duties as a paramedic.

The privacy of all respondents will be protected. Individual responses will remain confidential and information gathered will be analyzed and reported in aggregate form only. There will be no possibility of identifying a survey respondent by his or her responses.

The time required to complete the survey is about 45 minutes. Participation in the study is entirely voluntary. You do not have to disclose any information against your will and you may withdraw your participation at any time.

The survey is being conducted in several North Carolina EMS systems and is designed to assess drug calculation skills. The information gathered from this survey will be used to identify the types of errors made by paramedics and to devise new educational programs to improve drug calculation skills. Your voluntary participation in this project is important to the overall success of the project.

If you wish to discuss this research with someone else, you may contact Dr. Michael W. Hubble, Emergency Medical Care Program Director, Western Carolina University at (704) 227-7113 or Dr. Steve Yurkovich, IRB Chairperson, at (704) 293-9641.

Do you have any questions?

Are you willing to contribute your time to complete the survey?

I, _____ freely and voluntarily agree to participate in the research
(print your name here)
study as described above. I have been given the opportunity to ask, and have answered to my full satisfaction, questions pertaining to the research. I further attest that I am at least 18 years of age.

_____ Date _____
(signature)

Please answer the following questions:

1. Please indicate the agency for which you work.

   ❑ Caswell ❑ Henderson
   ❑ Chatham ❑ Jackson
   ❑ Garner Rescue ❑ Montgomery
   ❑ Guilford ❑ Mecklenburg
   ❑ Haywood ❑ Randolph

2. How many years have you been involved in EMS?
   _____ years

3. How many years have you been a paramedic?
   _____ years

4. Is your paramedic position part-time or full-time?

   ❑ full-time ❑ part-time

5. On average, how many hours per week do you work in EMS?

   _____ hours per week

6. On average, to how many EMS calls per week do you respond?

   _____ calls per week

7. On average, how many IVs do you start each week?

   _____ IV starts per week

8. On average, how many IV medication boluses do you administer each week?

   _____ medication boluses per week

9. On average, how many IV medication infusions do you initiate or maintain each week?
   _____ infusions per week

10. Please indicate your level of education:
    ❑ High School or GED
    ❑ Some college work
    ❑ Technical degree
    ❑ Baccalaureate degree
    ❑ Some graduate work
    ❑ Graduate degree

11. Please indicate your level of EMS education:
    ❑ Certificate program
    ❑ Technical degree
    ❑ Baccalaureate degree
    ❑ Graduate degree

12. Please indicate your gender:
    ❑ male ❑ female

13. How long has it been since you received your initial paramedic education?
    ❑ within the past year
    ❑ 1 year to 3 years
    ❑ 4 years to 6 years
    ❑ 7 years to 9 years
    ❑ 10 years or more

14. How long has it been since you received training in drug calculations?

    ❑ not since my initial paramedic training
    ❑ within the past month
    ❑ 1 month to 3 months
    ❑ 4 months to 6 months
    ❑ 7 months to 1 year
    ❑ 2 years to 3 years
    ❑ over 3 years ago

15. In the overall performance of your duties as a paramedic, how stressful are drug dosage calculations?

    ❑ not stressful at all
    ❑ somewhat stressful
    ❑ very stressful

16. If you received an order to initiate an intravenous infusion at 250 cc/hour, how would you determine the proper drip rate?

- ❑ look up in IV flow rate table
- ❑ calculate by hand
- ❑ calculate with calculator
- ❑ contact medical control for flow rate
- ❑ ask partner to calculate proper rate
- ❑ estimate proper flow rate
- ❑ other (specify)_____

17. If you received an order to administer 5 mg/kg of Bretylium to your patient weighing 190 pounds and were supplied with 500mg of Bretylium in 10 ml, how would you determine the proper dosage to be administered?

- ❑ look up in drug dosage table
- ❑ calculate by hand
- ❑ calculate with calculator
- ❑ contact medical control for dosage
- ❑ ask partner to calculate proper dosage
- ❑ estimate proper dosage
- ❑ other (specify)_____

18. If you received an order to initiate an infusion of Dopamine to run at 12 ug/kg/min and your patient weighed 190 pounds, how would you determine the proper drip rate?

- ❑ look up in dopamine drip table
- ❑ calculate by hand
- ❑ calculate with calculator
- ❑ contact medical control for drip rate
- ❑ ask partner to calculate drip rate
- ❑ estimate proper drip rate
- ❑ other (specify)_____

19. How comfortable do you feel with calculating **IV flow rates**?
    - ❑ very comfortable
    - ❑ somewhat comfortable
    - ❑ somewhat uncomfortable
    - ❑ very uncomfortable

20. How comfortable do you feel with calculating **IV bolus medication dosages**?
    - ❑ very comfortable
    - ❑ somewhat comfortable
    - ❑ somewhat uncomfortable
    - ❑ very uncomfortable

21. How comfortable do you feel with calculating **IV medication infusion rates**?
    - ❑ very comfortable
    - ❑ somewhat comfortable
    - ❑ somewhat uncomfortable
    - ❑ very uncomfortable

22. How often does your employer offer classes in drug calculation skills?
    - ❑ during new employee orientation
    - ❑ monthly
    - ❑ quarterly
    - ❑ yearly
    - ❑ greater than 1 year
    - ❑ never

23. How often do you practice drug calculations on your own?
    - ❑ monthly
    - ❑ quarterly
    - ❑ yearly
    - ❑ greater than 1 year
    - ❑ never

24. Do you routinely carry a calculator with you during your shift?
    ❑ yes ❑ no

25. Do you routinely carry weight conversion charts with you during your shift?
    ❑ yes ❑ no

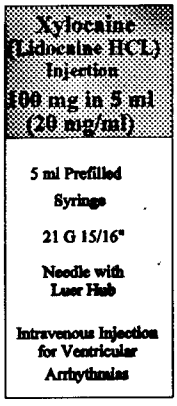
26. Do you routinely carry IV flow rate tables with you during your shift?
    ❑ yes ❑ no

27. Do you routinely carry drug dosage tables with you during your shift?
    ❑ yes ❑ no

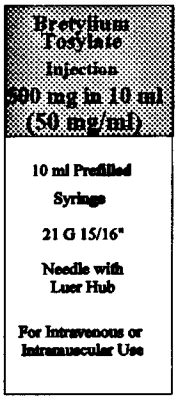
28. You are ordered to initiate an intravenous infusion of Normal Saline to run at 200 cc/hour. You are supplied with 1000 cc of NS and a 12 gtts/cc administration set. What is the IV flow rate in drops per minute? Please show all of your work and circle your final answer.

29. You are ordered to initiate an intravenous infusion of Lactated Ringer's Solution to run at 150 cc/hour. You are supplied with 1000 cc of Lactated Ringer's Solution and a 10 gtts/cc administration set. What is the IV flow rate in drops per minute? Please show all of your work and circle your final answer.

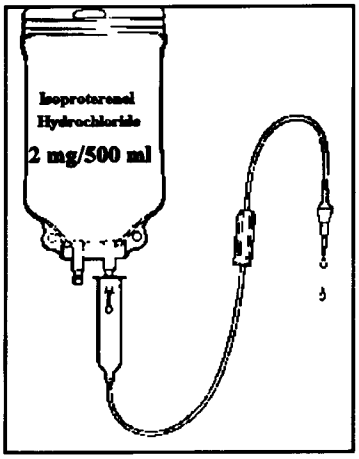
30. You are ordered to administer 1.5 mg/kg of Lidocaine to your patient who weighs 187 pounds. You are supplied with the Lidocaine package below. How many milliliters of Lidocaine will you administer to your patient? Please show all of your work and circle your final answer.



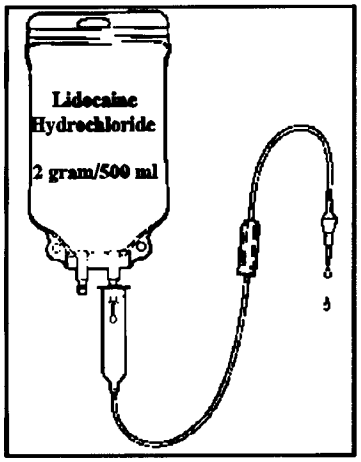
31. You are ordered to administer 5 mg/kg of Bretylol to your patient who weighs 143 pounds. You are supplied with the Bretylol package below. How many milliliters of Bretylol will you administer to your patient? Please show all of your work and circle your final answer.



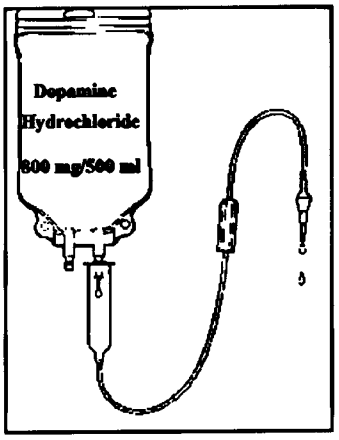
32. You are ordered to initiate an intravenous infusion of Isoproterenol at 5 µg/minute. You are supplied with the premixed package of Isoproterenol shown below and a 60 gtts/ml administration set. What is the IV flow rate in drops per minute? Please show all of your work and circle your final answer.



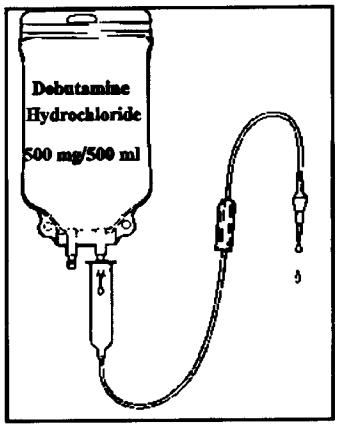
33. You are ordered to initiate an intravenous infusion of Lidocaine at 3 mg/minute. You are supplied with the premixed package of Lidocaine below and a 60 gtts/ml administration set. What is the IV flow rate in drops per minute? Please show all of your work and circle your final answer.



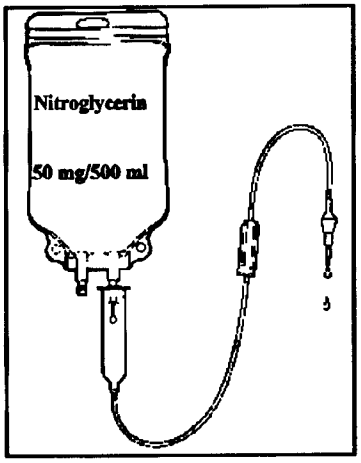
34. You are ordered to initiate an intravenous infusion of Dopamine at 4 µg/kg/minute to your patient who weighs 209 pounds. You are supplied with the premixed package of Dopamine shown below and a 60 gtts/ml administration set. What is the IV flow rate in drops per minute? Please show all of your work and circle your final answer.



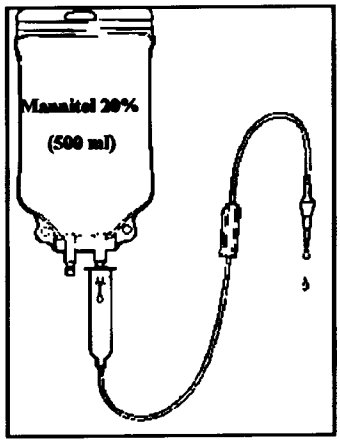
35. You are ordered to initiate an intravenous infusion of Dobutamine at 5 µg/kg/minute to your patient who weighs 154 pounds. You are supplied with the premixed package of Dobutamine shown below and a 60 gtts/ml administration set. What is the IV flow rate in drops per minute? Please show all of your work and circle your final answer.



36. You are ordered to maintain an intravenous infusion of Nitroglycerin at 5 µg/minute to your patient. You are supplied with the premixed package of Nitroglycerin shown below and a 60 gtts/ml administration set. What is the IV flow rate in drops per minute? Please show all of your work and circle your final answer.



37. You are ordered to initiate an intravenous infusion of Mannitol at 1 gram/kg to be administered over a period of 20 minutes. You are supplied with the premixed package of Mannitol shown below and a 60 gtts/ml administration set. What is the IV flow rate in drops per minute? Please show all of your work and circle your final answer.



Thank you for your time and your contribution to the EMS profession.