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Changes to DA-CPR instructions: Can we reduce time to first compression and improve quality of bystander CPR?☆

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ABSTRACT

Introduction: Dispatcher-assisted CPR (DA-CPR) can increase rates of bystander CPR, survival, and quality of life following cardiac arrest. Dispatcher protocols designed to improve rapid recognition of arrest and coach CPR may increase survival by (1) reducing preventable time delays to start of chest compressions and (2) improving the quality of bystander CPR.
Methods: We conducted a randomized controlled trial comparing a simplified DA CPR script to a conventional DA CPR script in a manikin cardiac arrest simulation with lay participants. The primary outcomes measured were the time interval from call receipt to the first chest compression and the core metrics of chest compression (depth, rate, release, and compression fraction). CPR was measured using a recording manikin for the first 3 min of participant CPR.
Results: Of the 75 participants, 39 were randomized to the simplified instructions and 36 were randomized to the conventional instructions. The interval from call receipt to first compression was 99 s using the simplified script and 124 s using the conventional script for a difference of 24 s ($p < 0.01$). Although hand position was judged to be correct more often in the conventional instruction group (88% versus 63%, $p < 0.01$), compression depth was an average 7 mm deeper among those receiving the simplified CPR script (32 mm versus 25 mm, $p < 0.05$). No statistically significant differences were detected between the two instruction groups for compression rate, complete release, number of hands-off periods, or compression fraction.
Discussion: Simplified DA-CPR instructions to lay callers in simulated cardiac arrest settings resulted in significant reductions in time to first compression and improvements in compression depth. These results suggest an important opportunity to improve DA CPR instructions to reduce delays and improve CPR quality.

1. Introduction

Bystander CPR improves survival from cardiac arrest, but rates of bystander CPR remain low despite a witnessed collapse rate of over 50%.[1] Dispatcher-assisted CPR (DA-CPR) can increase rates of bystander CPR, survival,[2] and quality of life[3] following cardiac arrest. However, there are still opportunities to improve upon delivery of DA CPR. Protocols designed to strengthen rapid recognition of arrest and coach bystanders may hold the greatest hope for increasing survival by (1) reducing preventable time delays[4,5] to start of chest compressions and (2) improving the quality of bystander CPR.[6] In this study, we conducted a manikin cardiac arrest simulation to compare a simplified set of DA CPR instructions against a conventional set of instructions with lay participants to determine if the simplified instructions could reduce the time to recognition and improve CPR performance.

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1.1. Time delays to chest compressions

The "all-caller" interview is a standardized method for gathering basic information to guide dispatch decisions at the start of all 911 calls. Following a defined querying interview protocol at the start of all calls helps identify cardiac arrests and reduces time delays to start of CPR.[7,8] However, another source of delay may in part be due to the ordering of questions in the defined interview protocol. The present research re-sequenced the cardiac arrest screening questions before other less-urgent questions (patient gender, caller name, and caller phone number).

1.2. Lay responder CPR quality

Quality of bystander CPR may be influenced by low health literacy[9,10] and language barriers,[11,12] as several of the commonly used words (conscious, bare the chest, heel of the hand) may not be well-understood by some callers. Additionally, lay bystanders rarely reach recommended guideline parameters for compression depth,[13,14] which may in part be due to difficulty estimating measurements (i.e., push 2 inches) or fear of causing harm. Simplification of instructions can increase rates of bystander CPR[15] (i.e., the 2010 AHA guideline recommendation compression-only CPR for bystanders), and simplification of DA CPR scripts has also improved quality of CPR in simulation studies in selected populations.[16,17]

We hypothesized that the simplified CPR instructions would result in a shorter time to first compression and higher quality CPR performance as measured by compression depth compared to conventional instructions.

2. Methods

2.1. Design, setting, and participants

This study was a randomized controlled trial comparing two DA CPR scripts (Table 1) in a manikin cardiac arrest simulation.

The study took place in Seattle and King County, Washington. All study procedures were reviewed and approved by Human Subjects at the University of Washington. Recruitment and administration occurred from July 2010 to August 2011.

The study population consisted of Seattle and King County residents age 40 or older, who spoke English as their primary language ($n = 86$).

Participants were recruited from flyers mentioning first aid but not CPR. The study evaluation took place at local community and retirement centers. Participants provided written consent and received a $25 gift card and education about CPR following the simulation.

2.2. Simplified DA CPR script development

The simplified (test) script was developed as part of a larger effort to address the barriers to dispatcher-assisted CPR especially among limited English proficient immigrant populations.[11,18,19] We convened focus groups with Mandarin, Cantonese and Spanish speakers to determine what phrases or words were challenging to understand and what alternatives might help understanding. Additionally, we interviewed dispatchers about their perception of words and phrases that challenged callers. Based on these efforts, the simplified dispatcher script was re-ordered to prioritize arrest identification by querying about consciousness and breathing normally (Table 1).

The dispatcher script also changed particular words and phrases in the CPR instructions that were judged to produce confusion, potential delay, and/or suboptimal bystander performance. The goal of these changes was to achieve more timely and guideline-compliant chest compressions. For example, changes in the simplified script included: (1) callers were no longer asked if they wanted to do CPR prior to beginning to provide CPR instructions; (2) callers counted in cycles of 10 (1, 2, 3...9, 10) versus 50 (1, 2, 3...49, 50); and (3) terms such as "bare the chest" and "push 2 inches" were replaced with "open the shirt," and "using straight arms, push as hard as you can," (Table 2).

Adult CPR instructions published in Criteria Based Dispatch[20] served as the comparison script. The algorithm used to identify cardiac arrest and provide dispatcher-assisted CPR is included in this script. These instructions have been evaluated with regard to their ability to identify cardiac arrest patients and implement resuscitation and derives from best practices guidelines.[20–22]

2.3. Simulation and randomization

Participants were provided a consistent scenario of a collapsed individual (a Laerdal Skill Reporter™ manikin). Participants were informed that the individual was "not conscious or awake and not breathing," and they were given a cell phone and were told to call "911" (a study number). The call was answered remotely by an experienced 9-1-1 dispatcher who guided callers through the randomized dispatcher scripts. The dispatcher had training in both the standard and the simplified script. To achieve randomization, the dispatcher opened an envelope with one of the two dispatcher scripts at the outset of each call. Randomization was stratified on age (40–60 years; over 60 years) and gender as both these factors have been associated with depth of compressions.[23] Calls were audio-recorded to assure compliance with the randomized dispatcher script.

2.4. Data definitions and outcomes

The primary outcomes of the study were the time interval from call receipt to the first chest compression and the core metrics of chest compression. Specifically we measured chest compression depth, rate, release, and interruptions. CPR metrics were assessed for the first 3 min of CPR performance. Sufficient compression depth was considered $\geq$38 mm. Sufficient compression rate was >100 compressions per minute. All data other than time to first compression, including hand position, were obtained by the Laerdal Skill Reporter™ manikin. We defined the no flow fraction as the period of time during the first 3 min following initial compression during which compressions were not being performed. We used a uniform data collection form to gather information about demographic characteristics and prior CPR training.

2.5. Sample size

The sample size was estimated to achieve 80% power to detect a 16 compressions-per-minute rate difference and a 6.7 mm depth difference according to the dispatcher script. Although the clinical implications of these differences are not clear-cut, increasing evidence from emergency medical services resuscitation studies suggest that these differences could influence clinical outcomes.[24,25]

2.6. Statistical analysis

Time and compression data were excluded for 11 participants with physical limitations that prevented them from moving the manikin from the table. The manikin failed to record data for 7 participants, who were thus excluded from analyses of quality measures (but were included in the time analysis).

We used the 2-sample t-test to compare interval from call receipt to first chest compression, total hands-off time, the number

Table 1
Original and re-sequenced questions in the all-caller interview.

Conventional instruction	Revised instruction
• 911: What are you reporting? • What is the address of the patient? • What is the patient's age? Gender? • What is the telephone number you are calling from? • What is your name? • Is the person conscious (awake, responding to you)? • Is the person breathing *normally*? **If patient is not conscious and not breathing normally, begin CPR**	• 911: Police, fire, or medical? • What is the address? • Are you the patient? • Are they able to talk to you? • Are they breathing *normally*? • About how old is the patient? **If patient is not conscious and not breathing normally, begin CPR** <u>Ask after CPR established:</u> • (If you don't know patient gender): Is the person a man or a woman? • What is the phone number you are calling from? • What is your name?

Table 2
Comparison of simplified and conventional DA CPR instructions.

Conventional DA CPR instructions	Simplified DA CPR instructions
• Does anyone there know CPR? *(Trained bystanders may still need instructions. Ask!)* • Get the phone NEXT to the person. • Listen carefully. I'll tell you what to do. • Get them FLAT on their back on the floor. • BARE the chest. • KNEEL by their side. • Put the HEEL of your HAND on the CENTER of their CHEST, right BETWEEN the NIPPLES.	• We need to help them. I am sending an ambulance and I will tell you what to do. • Get them on their back on the floor. • Get by their side on your knees. • Quickly open their shirt. • Put your hand on the middle of the chest. • Put your other hand on top of that hand • With straight arms push down as <u>hard as you can</u>. Push hard and count with me, "1, 2, 3, 4, 5, 6, 7, 8, 9, 10".
• Put your OTHER HAND ON TOP of THAT hand.	*(Note: Count along with caller to check rate. Give encouragement and feedback when caller returns to phone if their rate is much faster or slower than recommended by guidelines)*
• PUSH DOWN FIRMLY, ONLY on the HEELS of your hands, 2 inches. • Do it <u>50</u> times, just like you're PUMPING the chest. Count OUTLOUD 1-2-3. . .50	
****(correct rate if needed)*	• Keep going, push hard and count to 10 again and again.
• KEEP DOING IT: KEEP PUMPING the CHEST UNTIL HELP TAKES OVER. I'll stay on the line.	• Keep pushing as hard as you can, don't stop until help arrives. I'll stay on the phone.

of hands-off periods, mean compression depth, and compression rate according to the randomized dispatcher script. We also made comparisons with the Wilcoxon rank sum test to account for potential skewness of the outcome measures. We used chi-squared tests and logistic regression to compare categorical measures (complete release, compressions >38 mm, correct hand position, and sufficient rate). All statistical analyses were performed in R version 2.13.

3. Results

A total of 86 people were enrolled in the study: initially 42 were randomized to the simplified script and 44 were randomized to the conventional script. After accounting for exclusions, 39 individuals remained in the simplified script group and 36 in the conventional script group. There were no gender, age, racial, or CPR training differences for these participants whose data was excluded compared to those whose data was analyzed. We did not observe statistically significant differences between the two groups with regard to demographic characteristics (Table 3).

The interval from call receipt to first compression was 99 s using the simplified script and 123 s using the conventional script for a difference of 24 s between the two scripts (Table 4). Participants randomized to the simplified script on average provided deeper compressions compared to the traditional standard script. Compression depth was an average 6.4 mm deeper among those receiving the simplified CPR script ($p < 0.05$), with 31.3 percent of compressions greater than 38 mm compared to only 20% for the conventional instructions. Conventional instructions were judged to have correct hand placement more frequently (88% versus 63% $p < 0.01$). No differences were detected between the two instruction groups for compression rate, complete release, number of hands-off periods, or total hands-off time.

4. Discussion

In this simulation trial, participants randomized to the simplified DA CPR script started chest compressions 24 s sooner than those who received the conventional instructions; this difference is likely due to the time saved by the dispatcher asking fewer questions prior to establishing that "the patient" was not breathing and not conscious. A 24 s interval could be clinically meaningful and translate to measureable improvement in patient outcomes as survival from cardiac arrest declines 5–10% for every minute without CPR.[26] This finding compliments other simulation investigations that have observed time reduction to starting CPR if the step to remove clothing and "bare the chest" is removed from the dispatcher instruction.[27,28] Taken together, the findings suggest that efforts to prioritize arrest identification and eliminate steps preceding hands on the chest can impact time delays, underscoring the critical role of the emergency dispatcher in the chain of survival.

Additionally, simplifying the terminology used in DA CPR instructions resulted in greater chest compression depth on average compared to conventional instructions. This finding adds further support that using the language "push as hard as you can" is a more effective instruction for adequate CPR compression depth compared to giving callers a specific depth.[12] Greater compression depth was achieved even though hand position was judged to be correct less often with the simplified instructions. Overall, compression depth continued to be sub-optimal regardless of the instruction and further research into how compression depth in DA CPR can be improved is needed. It may be that if hand position was improved, the simplified instructions could achieve better

Table 3
Participant characteristics.

Characteristics	Simplified scripts (*n* = 39)	Conventional scripts (*n* = 36)	*p*-value
Age, mean (SD)	60.6 (12.5)	60.6 (13.7)	0.99
Gender, *n* (%)			1.00
Female	29 (78%)	28 (78%)	
Race, *n* (%)			0.39
White	22 (58%)	16 (44%)	
African American	10 (26%)	15 (42%)	
Other	6 (16%)	5 (14%)	
Ever taken prior CPR class, *n* (%)	10 (28%)	7 (21%)	0.35

Table 4
CPR outcomes.

Outcome	Simplified (*n* = 39)					2010 CBD (*n* = 36)					Observed difference (95% CI)	*p*-value
	n	mean (SD)	25th	50th	75th	*n*	mean (SD)	25th	50th	75th		
Time to first compression (s)	39	99 (28)	76	95	116	36	123 (28)	104	122	138	−24.3 (−11.3, −37.4)	<0.01
Compression depth (mm)	36[a]	32 (13)	25	32	41	34[a]	25 (14)	13	23	34	6.8 (−13.4, −0.6)	<0.05
% of compressions ≥38 mm[d]	36[b]	33 (38)	0	15	55	33[b]	20 (33)	0	0	22	12.7 (−4.4, 29.7)	0.14
Chest compression rate[d]	33[c]	102 (29)	97	106	118	32[c]	93 (26)	64	97	117	9.0 (−7.0, 23.0)	0.34
% Sufficient rate[d]	33[c]	24 (25)	4	13	38	32[c]	19 (20)	2	13	39	3.5 (−7.0, 15.7)	0.45
% Complete release[d]	36[a]	89 (20)	87	99	100	34[a]	92 (21)	98	100	100	2.5 (−12.5, 7.5)	0.62
% Correct hand position[d]	36[b]	63 (37)	30	72	99	33[b]	86 (28)	94	100	100	−22.7 (−38.3, −7.0)	<0.01
Number of hands off periods	36[b]	5.3 (6.2)	2.0	3.5	5.3	33[b]	5.4 (5.2)	2.0	4.0	7.0	−0.1 (−2.9, 1.0)	0.95
Total hands off time (s)	36[b]	39 (40)	11	26	51	33[b]	41 (31)	23	33	53	−2.4 (−19.6, 14.7)	0.78
Compression fraction	36[b]	78 (78)	72	86	93	33[b]	77 (83)	71	82	87	1.1 (10.9, 8.2)	0.78

[a] For 5 individuals the manikin failed to record data.
[b] For an additional 1 individual the manikin did not record a sufficient number of compressions to calculate this quality measure.
[c] For an additional 4 individuals the manikin did not record enough compressions of sufficient depth to calculate a compression.
[d] Percent measures are within participant, so each measurement is the percentage of that participants compressions that meet the specific criteria.

compression depth performance. The revised instructions omitted the phase “right between the nipples” in the hand placement instructions, and this instruction may act as a way to guide the location of hand placement along the long axis of the body. Suboptimal placement along this axis may hinder the depth of compression achieved (which along with compression rate is of primary importance for CPR efficacy).

Although CPR quality was improved in relation to chest compression depth with simplified DA CPR, both script groups performed similarly with regard to rate, release, hand position, hands off periods, and hands off time, there was no evidence to support a difference between the two scripts with regard to these measures. These findings offer further opportunities to revise and improve DA CPR instructions.

5. Limitations

The study was limited by virtue of being a manikin simulation study; citizen bystanders in real cardiac arrest situations may behave differently, and we cannot be certain that the differences observed in this study would translate into differences in real cardiac arrest situations. There is a need to examine the quality of bystander CPR in real life events, something that might be possible with data collected from field use of Automatic External Defibrillators (AEDs). Because the participants were told prior to the start of the simulation that the patient was unconscious and not breathing the study cannot account for any effect of the script revision on the time it would take to determine the need to perform CPR. The study had limited power to detect differences in CPR performance and only evaluated the first 3 min of single rescuer compression-only CPR. A larger sample size or more extended measurement could produce different results. Importantly, the study cohort was older, predominantly women, and included substantial racial minorities; characteristics that mirror the rescuer in the real arrest circumstance and so support the generalizability of the results to the population that typically performs DA CPR; however differences between this population and the general population could limit generalizability to the latter.

Another limitation is that the study included the phrase “open the shirt”, instructions which have subsequently been removed from the instructions.

6. Conclusion

Simplified dispatcher CPR instructions to lay callers in simulated cardiac arrest settings resulted in significant reductions in time to first compression and improvements in compression depth. These results suggest an important opportunity to improve DA CPR instructions to reduce delays and improve CPR quality. Even with these improvements, CPR performance was suboptimal, providing the rationale for further investigation and implementation of best practices for dispatcher-caller communication. Advances have the potential to reduce the burden of death and disability from cardiac arrest.

Conflict of interest statement

The authors have no conflict of interest to disclose.

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References

1. Sasson C, Rogers MAM, Dahl J, Kellermann AL. Predictors of survival from out-of-hospital cardiac arrest: a systematic review and meta-analysis. Circ Cardiovasc Qual Outcomes 2010;3:63–81. Available at: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=medc&AN=20123673

2. Rea TD, Eisenberg MS, Culley LL, Becker L. Dispatcher-assisted cardiopulmonary resuscitation and survival in cardiac arrest. Circulation 2001;104:2513–6. Available at: http://circ.ahajournals.org/cgi/doi/10.1161/hc4601.099468
3. Stiell I, Nichol G, Wells G, et al. Health-related quality of life is better for cardiac arrest survivors who received citizen cardiopulmonary resuscitation. Circulation 2003;108:286–91. Available at: http://www.ncbi.nlm.nih.gov/pubmed/14530198
4. Hauff SR, Rea TD, Culley LL, et al. Factors impeding dispatcher-assisted telephone cardiopulmonary resuscitation. Ann Emerg Med 2003;42:731–7. Available at: http://www.ncbi.nlm.nih.gov/pubmed/14634595 [accessed 06.10.11].
5. Culley LL, Clark JJ, Eisenberg MS, Larsen MP. Dispatcher-assisted telephone CPR: common delays and time standards for delivery. Ann Emerg Med 1991;20:362–6. Available at: http://www.ncbi.nlm.nih.gov/pubmed/2003662
6. Aufderheide TP, Pirrallo RG, Yannopoulos D, et al. Incomplete chest wall decompression: a clinical evaluation of CPR performance by trained laypersons and an assessment of alternative manual chest compression–decompression techniques. Resuscitation 2006;71:341–51. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0300957206001973
7. Hauff SR, Rea TD, Culley LL, et al. Factors impeding dispatcher-assisted telephone cardiopulmonary resuscitation. Ann Emerg Med 2003;42:731–7.
8. Roppolo LP, Westfall A, Pepe PE, et al. Dispatcher assessments for agonal breathing improve detection of cardiac arrest. Resuscitation 2009;80:769–72. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19477058
9. Berkman N, Sheridan S, Donahue K. Health literacy interventions and outcomes: an updated systematic review. Evid Rep/Technol Assess 2011;199:I-144. Available at: http://www.ncbi.nlm.nih.gov/books/NBK82434/ [accessed 13.03.13].
10. Safeer RS, Cooke CE, Keenan J. The impact of health literacy on cardiovascular disease. Vasc Health Risk Manag 2006;2:457–64. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1994011&tool=pmcentrez&rendertype=abstract
11. Bradley SM, Fahrenbruch CE, Meischke H, et al. Bystander CPR in out-of-hospital cardiac arrest: the role of limited English proficiency. Resuscitation 2011;82:680–4. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21388734
12. Meischke H, Chavez D, Bradley S, Rea T, Eisenberg M. Emergency communications with limited-English-proficiency populations. Prehosp Emerg Care 2010;14:265–71.
13. Rea TD, Stickney RE, Doherty A, Lank P. Performance of chest compressions by laypersons during the Public Access Defibrillation Trial. Resuscitation 2010;81:293–6. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20044198
14. Dorph E, Wik L, Steen PA. Dispatcher-assisted cardiopulmonary resuscitation. An evaluation of efficacy amongst elderly. Resuscitation 2003;56:265–73.
15. Sakai T, Iwami T, Kitamura T, et al. Dispatcher instruction in chest compression-only CPR increases implementation of bystander CPR: the utstein osaka project. Circulation 2011;124:144. Available at: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed10&NEWS=N&AN=70621806
16. Mirza M, Brown TB, Saini D, et al. Instructions to "push as hard as you can" improve average chest compression depth in dispatcher-assisted cardiopulmonary resuscitation. Resuscitation 2008;79:97–102. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0300957208005121
17. Dias JA, Brown TB, Saini D, et al. Simplified dispatch-assisted CPR instructions outperform standard protocol. Resuscitation 2007;72:108–14. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0300957206003376
18. Yip MP, Ong BN, Meischke HW, et al. The role of self-efficacy in communication and emergency response in Chinese limited english proficiency (LEP) populations. Health Promot Pract 2011;111:9–10. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21462136
19. Yip M, Ong B, Tu S, et al. Diffusion of cardiopulmonary resuscitation training to Chinese immigrants with limited English proficiency. Emerg Med Int 2011;2011:8 (Article ID 685249).
20. Culley LL, Henwood DK, Clark JJ, Eisenberg MS, Horton C. Increasing the efficiency of emergency medical services by using criteria based dispatch. Ann Emerg Med 1994;24:867–72. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0196064494002234
21. Eisenberg MS, Hallstrom AP, Carter WB, et al. Emergency CPR instruction via telephone. Am J Public Health 1985;75:47–50. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1646147&tool=pmcentrez&rendertype=abstract
22. Clark JJ, Culley L, Eisenberg M, Henwood DK. Accuracy of determining cardiac arrest by emergency medical dispatchers. Ann Emerg Med 1994;23:1022–6. Available at: http://www.ncbi.nlm.nih.gov/pubmed/8185093
23. Dracup K, Heaney DM, Taylor SE, Guzy PM, Breu C. Can family members of high-risk cardiac patients learn cardiopulmonary resuscitation? Arch Intern Med 1989;149:61–4.
24. Idris AH, Guffey D, Aufderheide TP, et al. Relationship between chest compression rates and outcomes from cardiac arrest. Circulation 2012;125:3004–12.
25. Stiell IG, Brown SP, Christenson J, et al. What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation? Crit Care Med 2012;40:1192–8.
26. Cummins RO, Eisenberg MS, Hallstrom AP, Litwin PE. Survival of out-of-hospital cardiac arrest with early initiation of cardiopulmonary resuscitation. Am J Emerg Med 1985;3:114–9. Available at: http://www.sciencedirect.com/science/article/pii/0735675785900324
27. Eisenberg Chavez D, Meischke H, Painter I, Rea T. Should dispatchers instruct lay bystanders to undress patients before performing CPR? A randomized simulation study. Resuscitation 2012;84:979–81.
28. Mortensen RB, Høyer CB, Pedersen MK, Brindley PG, Nielsen JC. Comparison of the quality of chest compressions on a dressed versus an undressed manikin: a controlled, randomised, cross-over simulation study. Scand J Trauma Resusc Emerg Med 2010;18:16. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2859387&tool=pmcentrez&rendertype=abstract